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A METHODOLOGY FOR NURSING SALARY FORECASTING.

10 LT COLONEL F. THEODORE HELMER,
LT PAUL D. LEVY

DEPT OF ECONOMICS, GEOGRAPHY
AND MANAGEMENT
USAF ACADEMY, COLORADO 80840

DR. JAMES D. SUVER

SCHOOL OF BUSINESS
UNIVERSITY OF COLORADO,
COLORADO SPRINGS

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Editorial Review by Lt Col Elser
Department of English
USAF Academy, Colorado 80840

This research report is presented as a competent treatment of the subject, worthy of publication. The United States Air Force Academy vouches for the quality of the research, without necessarily endorsing the opinions and conclusions of the authors.

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Vice Dean of the Faculty

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The cost of health care has been spiraling for years, and the pressures to increase efficiency are becoming greater. This study presents several models capable of evaluating and relating hospital budgets to workloads. Specifically, we have developed models for forecasting nursing salary expenses in the OB/GYN ward, the Medical/Surgical ward, and for total nursing salary expenses. These models can be used for budgeting, measuring efficiency, and controlling nursing salary expense. The methodology can be applied to other wards within the hospital for monthly and yearly nursing salary predictions.

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INTRODUCTION

The cost of medical care in the United States has been spiraling for years. The military, as a provider of health care services, is accutely affected by these rising costs. With the military budget being stretched as far as possible, any increase in the efficiency with which the military can provide health care will ease the military's budget problems. Until recently, the military hospital simply did not feel the need to operate on a tight budget.

This study will explain a group of models capable of evaluating and then linking budget expenditures to hospital workloads. The models presented in this study tie hospital expenses to workload, specifically in the area of Nursing Salary Expense. We envision that the military hospitals would gain a great deal by employing similar econometric models relating workload to budget. The type of models presented in this study serves to increase hospital operating efficiency and ultimately to reduce hospital costs.

THE BUDGETING PROCESS

The budget is being used extensively in both profit and non-profit organizations to control costs. A properly designed budget can serve as a plan for action, a communicative device to inform employees of management goals, a motivation aid to cost conscientiousness, and finally a control device for monitoring performance.

The concept of budgeting is not new to hospitals. Some administrators appear to use budgets more effectively than others, but all will agree that the budget is an important tool. As noted earlier, budgets are an important management control technique in profit organizations; however, they are the primary tool used to control costs in non-profit organizations where the profit measurement factor is not available. Proper budgeting may be the 'sin qua non' in non-profit organizations, such as in hospitals where it is extremely difficult to measure output. Factors such as quality and intensity of care provided serve to confuse conventional output measurement totals like patient days or number of procedures.

The input (resources consumed) side of the budget is relatively easy to measure. Since we know what has been spent, the primary problem becomes one of determining the actual outputs achieved. The actual output can vary from the expected output levels for which the budget was prepared. Given the variance from planned output, what are the inputs that should be used to most efficiently achieve the actual level of output? We have found that many hospitals currently compare actual expenditures against planned budgeted amounts without regard to these variations in output.

The model presented in this paper reinforces the flexible budget concept and provides an understanding of the nature of fixed and variable costs. Most organizations encounter two types of costs. The first type varies directly with the volume of output being achieved. For example, the number of patients in a

ward should influence the costs for drugs, meals, and some other individual services. This type is considered "variable costs." Conversely, some costs, such as building, utilities, insurance, etc., vary directly with the number of patients. These costs are commonly referred to as "fixed costs." For example, the number of beds, the administrative staff, and the depreciation expense would not be expected to increase with the addition of one more patient. The concept of flexible budgeting stresses that variable costs are the only costs that should change with the output. Therefore, the budget for different patient loads can be determined and actual expenditures measured against the budget for the actual output. This measurement removes the impact of a volume variance from the analysis and allows management to concentrate on controllable factors, such as spending and efficiencies.

Although simple in concept, the major difficulty comes in analyzing those costs that are both fixed and variable. For example, two nurses may be able to provide service to five patients. The addition of a sixth patient means that another nurse must be hired. Clearly, the sixth patient should not be charged for the entire costs of the third nurse because a seventh patient can now be added without incurring additional nursing salary expense. These costs, typically called semi-variable (or "semi-fixed"), cause considerable difficulty in the implementation of a flexible budget concept. Many hospitals use patient days as a valid output

measurement, but this figure is not the sole determinant of changes in total costs. The models developed in this paper will suggest other good measures, and hopefully allow administrators to more fully appreciate the potential of a flexible budget.

METHODOLOGY

In order to implement a flexible budgeting process, we developed statistical models which can be used both to predict the level of variable costs and also to determine what specific work-load (output) factors explain the level of costs incurred. With the enthusiastic cooperation of a local non-profit 400-bed general hospital, we took a careful look at the time-phased trends in each ward's workload, nursing manhours, nursing salaries, and the total hospital's salaries for each month. (Total salary expense is 70% nursing salaries.) Thirty-five consecutive months of data starting from October 1974 were used in the development of the model, and we purposely restricted ourselves to using data from the Hospital Administrative Services (HAS) reports for future inter-hospital comparisons. As of this writing, models predicting nursing salaries for the O.B. ward, the Medical/Surgical ward, and for total hospital salary expense have been developed. Figure 1 contains a graph of total nursing salaries over time; it shows that the nursing salaries are increasing over time at a steady rate. This rise is alarming when one studies the workload indicators over time and learns that,

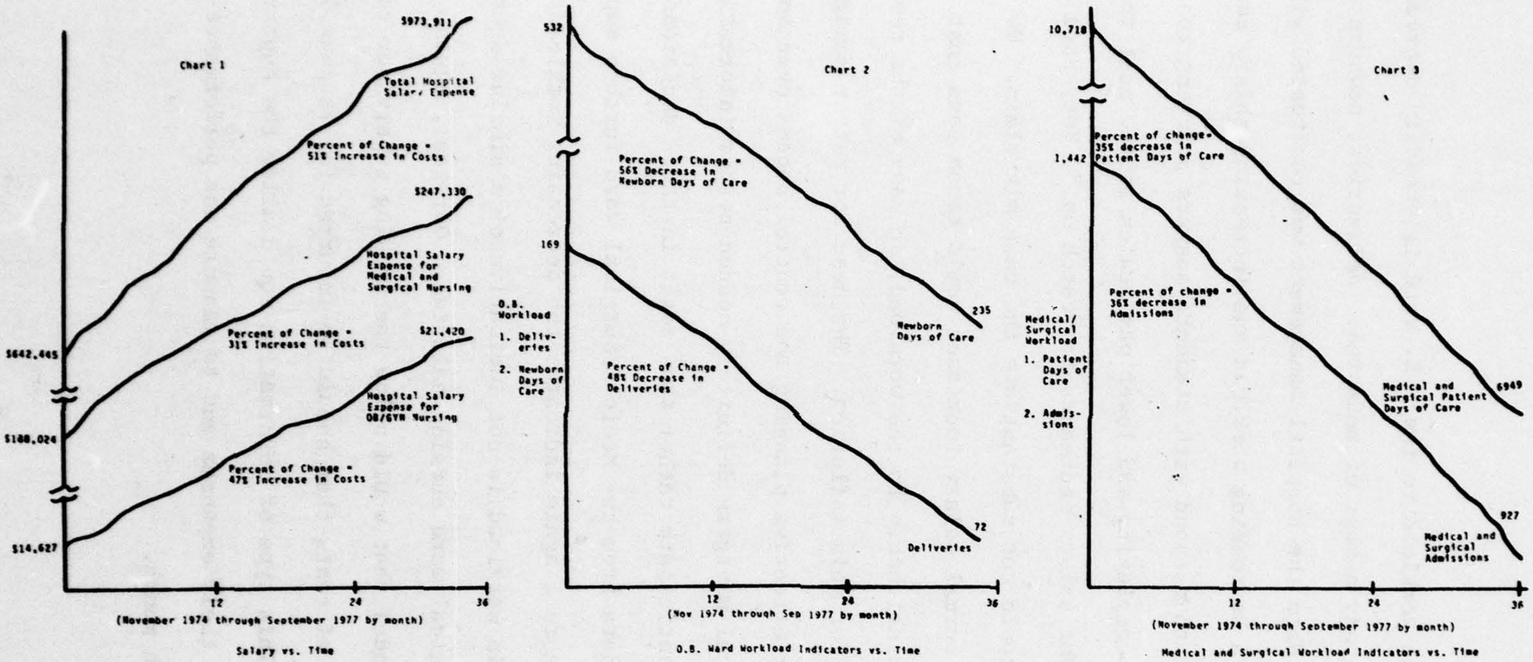


FIGURE 1. WORKLOADS AND SALARIES VS. TIME

for example, the workload in the O.B. ward is steadily decreasing over time using any number of measures: deliveries, newborn days of care, etc. When the hospital management was confronted with the reality of a decreasing workload and increasing salary costs, they were quick to respond with standard answers pointing to increased case complexity and lower pay scales in the past that had caused recent salary increases to "catch up." Yet, data from the O.B. ward could not substantiate the case mix claim. We recognize that normal salary increases would cause some cost increases in relationship to the workload, so many of the resulting models allowed for this inflation. The need for better management information for effective planning and control became even more evident; hospital managers definitely needed better information so they could anticipate rather than react in their decisions.

The HAS data from the Medical/Surgical ward further supported this need. Figure 1 again indicates the decreasing workload, yet this decrease in workload is not indicative of a similar decrease in Medical/Surgical ward nursing salaries. Our goal, again, was to develop a model that would allow the nursing supervisor to predict the level of costs that should be incurred for various levels of workload. This type of information would allow the supervisors to better plan their expenses and to measure the performance at the end of each month.

Model Development--Stage One

The first phase of developing such a model was the collection of the time-phased data which, unfortunately, revealed that costs were increasing when workload was decreasing. This rather startling observation caused management to start investigating trends, only to discover that inflation was not the cause and that levels of inefficiency were increasing without an adequate explanation. (When cost figures were deflated using GNP deflators for each month, an increasing cost relationship remained.)

Model Development--Stage Two

The second phase of research was the development of regression models that could predict nursing salaries based upon historical cost and workload data. These models were developed from a great many iterations using the DETRUTH regression option available as software on a Burroughs 6700 computer. The resulting models in Figure 2 were very effective in predicting salary costs for both the O.B. and Medical/Surgical wards based upon planned workload. Further, the existence of a flexible budget model allowed the nursing supervisor to control the nursing salary costs for these two wards by making monthly comparisons of forecast vs. actual costs for the output achieved. Note that we are using historical data with historical efficiencies, and the predicted salary costs for each ward are built upon their own past experience. By removing the inflationary trend in salaries, the model would suggest that the level of efficiency on the ward should remain constant.

MODEL 1

Dependent Variables	Independent Variables
O.B. Nursing Salary	O.B. Admissions
	O.B. Patient Days
	Time

MODEL 2

Dependent Variables	Independent Variables
Medical and Surgical Nursing Salary	Medical and Surgical Admissions
	Medical and Surgical Patient Days of Care
	Total Discharges
	Time

MODEL 3

Dependent Variables	Independent Variables
Total Salary Expense	Total Discharges
	O.B. Nursing Salary
	Time

Figure 2. O.B., Medical/Surgical, and Total Salary Regression Forecast Models, with their Corresponding Independent Variables

At this stage, we operated the model in parallel with existing budgeting systems, and the nursing supervisor was given the predicted budgets each month for three months. By comparing actual costs with the predicted costs from the model and integrating management judgment on large deviations with the model's prediction, the nursing supervisors gained confidence in the technique.

Multiple Variable Regression Models

Three multiple variable regression models were formed to forecast and explain variations in O.B. Nurse Salary Expense, Medical/Surgical Salary Expense, and Total Hospital Salary Expense. For each of these dependent variables, many independent variables were evaluated in numerous combinations to attempt to model the dependent variable. For each dependent variable a final model is presented. The significant results and conclusions obtainable from these three models are shown in Figure 3.

RESULTS

The findings of this study fall into two interrelated categories. First, we have developed and analyzed nine single variable simple regression models relating workload and nursing salary to time. Second, we have developed multiple regression models for O.B. Ward Nurse Salary, Medical/Surgical Nurse Salary, and Total Hospital Salary Expense. These models are capable of forecasting Salary Expense values from workload input variables.

MODEL

	R^2	F-Statistic	Average Residual Error	Average Percent Error
O.B. Nursing Salary	.72	22.16	$700.2	3.7%
Medical & Surgical Nursing Salary	.63	14.92	$7703.7	3.4%
Total Salary	.92	121.48	$18,256.9	2.1%

Figure 3. Multiple Regression Models for the Forecasting of Hospital Salary Expenses with Accompanying Statistics

O.B. Ward Nursing Salaries

The first series of models developed in this study involves the hospital's O.B. ward. Detailed analysis of data showed that the key variables indicative of O.B. workload were newborn days of care and deliveries, and both were inversely related to time. Over the 35-month period of model evaluation, deliveries fell from a high of 169 to a low of 72, an almost linear decrease of 48 percent. Newborn days of care, over the same 35 month period of evaluation, declined over 56 percent. O.B. nurse salary, when similarly evaluated, was directly and positively related to time and increased by nearly 47 percent.

The above results describe an inverse relationship between workload and total salary expense over the 35 months studied. This surprising result, only partially explained by salary inflation, emphasizes the need for more efficient salary budgets and more effective control procedures.

Medical/Surgical Ward Nursing Salaries

The conflicting workload/salary trends uncovered in the O.B. model were further substantiated by an examination of the hospital's Medical/Surgical ward data and the hospital's total salary expense. Medical/Surgical workload indicators all pointed towards a decreasing volume of Medical/Surgical ward patients. Medical/Surgical patient days of care dropped from a high of 10,718 to a low of 6,949 with the trend line indicating a 35 percent decrease

over the 35 months evaluated. Medical/Surgical Admissions showed a drop of 36 percent while medical/surgical nursing salary expense increased over 31 percent. The trend once again indicates rising costs and diminishing workloads.

Total Hospital Salaries

When the total salary allocation for the hospital was examined, we observed an upward trend of over 51 percent during the 35 months. During this same period of evaluation, total discharges, a measure of aggregate hospital workload, declined by over 26 percent.

Workload and Cost Trends

Figure 4 summarizes our workload and cost analysis. The six workload variables evaluated all showed a substantial decline over the past three years. During this time, salary expense rose 40 percent. More interesting, maximum workloads tended to occur in 1974, while maximum salary expenses occurred in 1976 and 1977. The conclusion we can draw is that hospital efficiency is declining at a constant rate especially since case complexity is constant. Figure 1 substantiates this conclusion. The factor analysis summarized in Figure 4 brought the problem of inefficient and ineffective budgeting to the hospital's attention.

	Maximum Value	Date	Minimum Value	Date	% Change in Value of Trend Line
Newborn Days of Care	532	Nov 74	235	Jan 77	56% Decrease
Deliveries	169	Nov 74	72	Feb 77	48% Decrease
O.B. Nurse Salary Expense	$ 21,420	Mar 76	$ 14,627	Mar 74	47% Increase
Medical/ Surgical Admissions	1,442	Nov 74	927	Feb 77	36% Decrease
Medical/ Surgical Patient Days of Care	10,718	Dec 74	6,949	Sep 77	35% Decrease
Medical/ Surgical Discharges	1,584	Aug 74	908	May 77	43% Decrease
Medical/ Surgical Nursing Salary Expense	$247,330	Jul 76	$188,024	Nov 74	31% Increase
Total Discharges	1,587	Jan 75	1,167	Oct 76	26% Decrease
Total Salary Expense	$973,911	Aug 77	$642,445	Nov 74	51% Increase

Figure 4. Characteristics of Key Variables

Salary Expense Forecasting

Figure 2 presents the content of the three multiple regression models developed by this study.

O.B. nursing salary was regressed as a function of O.B. admissions, O.B. patient days of care, and time and the results presented in Figure 5. This model has been extremely accurate in forecasting O.B. nursing salary expense. When used to predict O.B. nursing salary based upon workload predictions, this model was accurate within two percent. Over the 35 month period of model evaluation, the model's average percent variation from actual nursing salary was 3.7 percent. The coefficient of Multiple Determination (R^2) was equal to .72, and a test of this model's F-statistic indicates that with a probability of .999, a relation exists between the dependent variable (O.B. Nurse Salary) and the set of independent variables.

Medical/surgical nursing salary varied as a function of medical/surgical admissions, medical/surgical patient days of care, total hospital discharges, and time. Over the 35 month period of model evaluation, this model's average percent variation from actual medical/surgical nursing salary was only 3.4 percent as shown in Figure 6. The model's coefficient of Multiple Determination is .63, and a check of this model's F-statistic also reveals that, with a certainty of .999, a regression relationship exists between the dependent variable (Medical/Surgical Nursing Salary) and the independent variables.

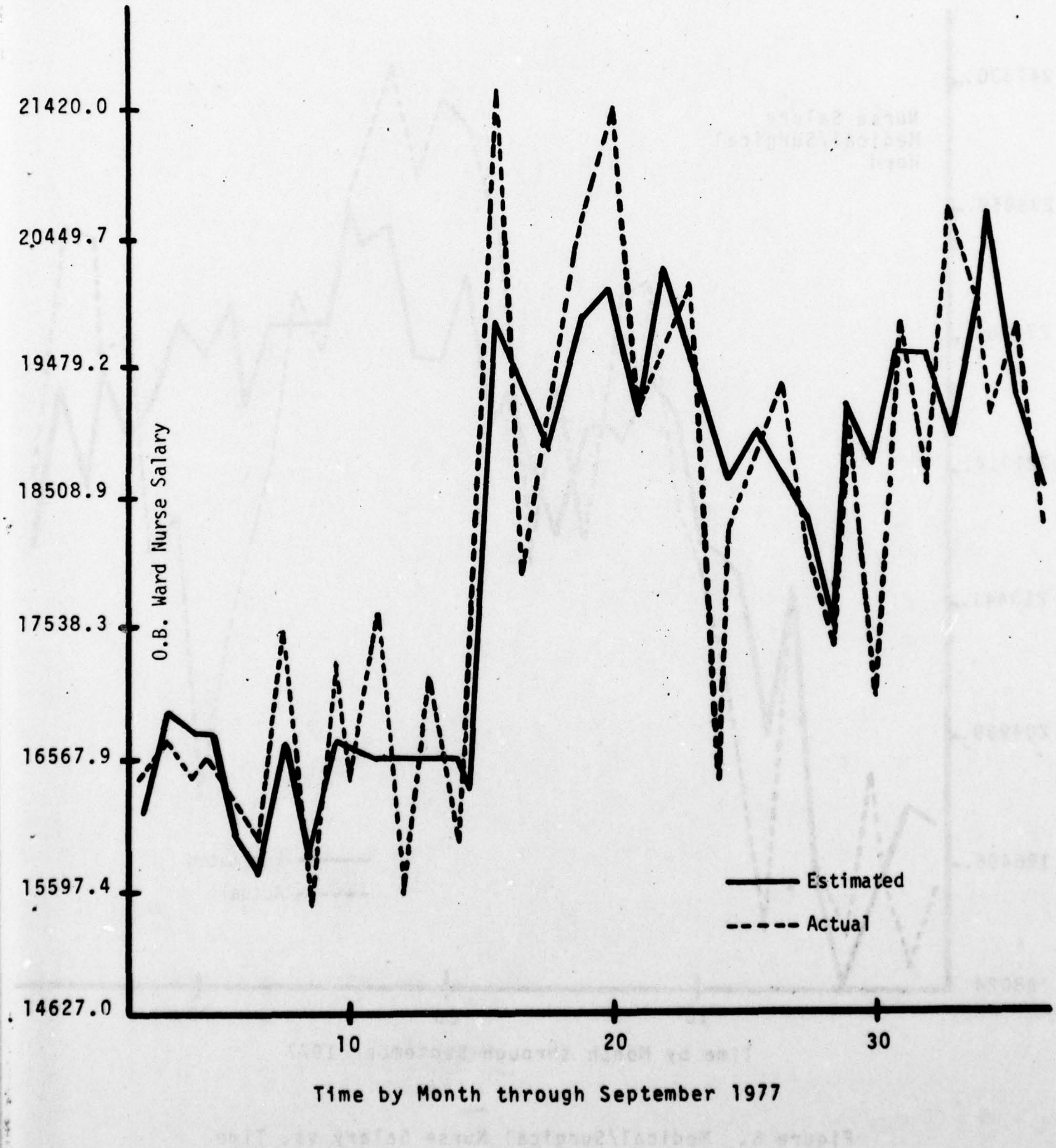


Figure 5. O.B. Nurse Salary vs. Time

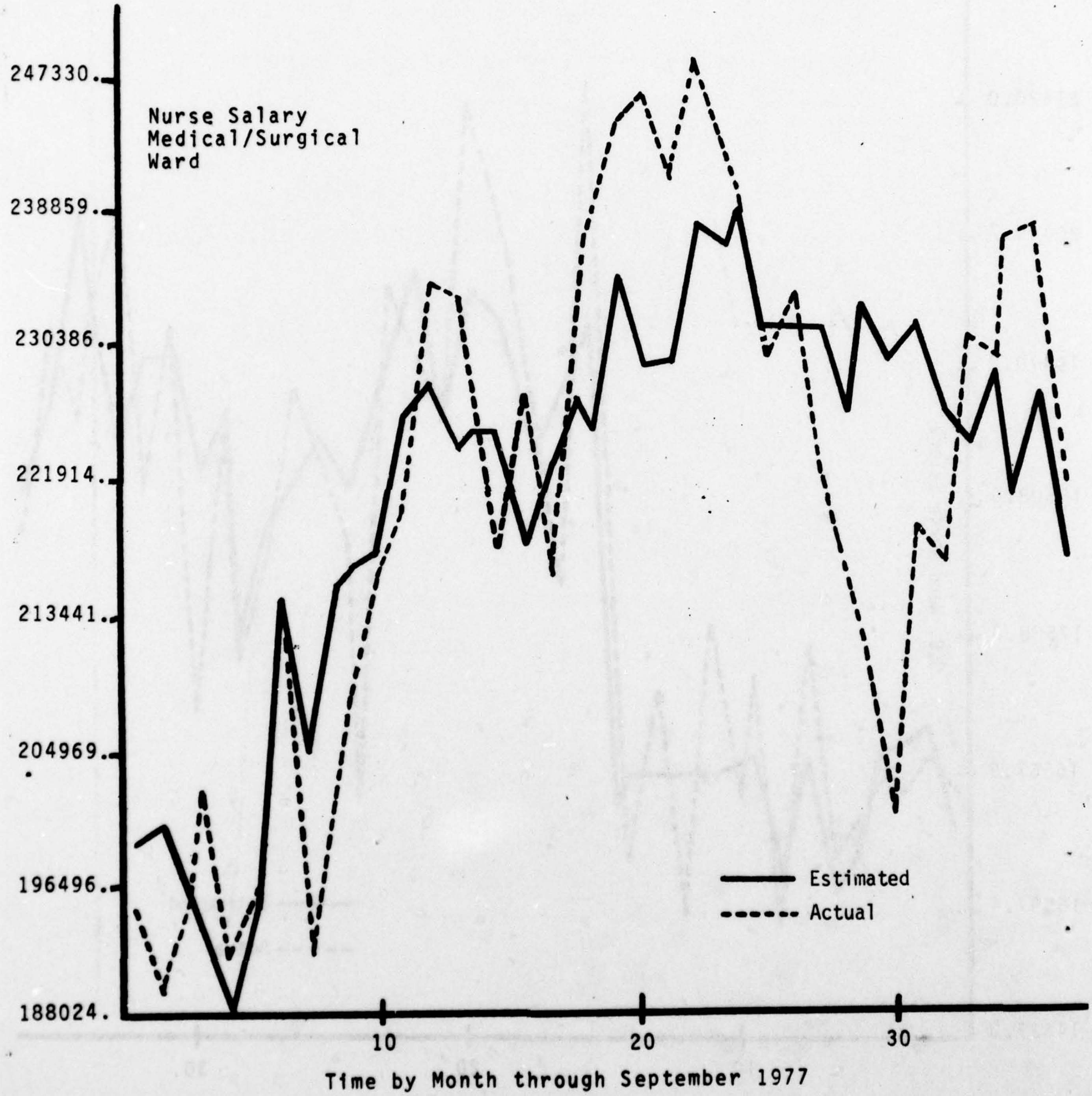


Figure 6. Medical/Surgical Nurse Salary vs. Time

The last model developed relates total hospital salary expense to total discharges, O.B. nurse salary, and time. The coefficient of multiple determination for this model is equal to .92, while the average residual error, attributed to this model over the 35 months, was only 2.1 percent. This model's F-statistic reveals that, with a certainty of .999, a regression relation exists between total salary expense and the variables used to model total salary expense (Figure 7).

Several points concerning the usage of the above described models should be clarified at this time. First, single variable time series regression analysis can serve as a useful indicator of trends in both cost and workload. These models allow hospital administrators to project, in a very simple and quick manner, workload and costs for future budget preparation. Second, the multiple regression forecast oriented models for nursing salary serve to inform administrators of what hospital budgets for nursing salary, based upon workload, should be in future months. These models can be evaluated with various workload assumptions, thus providing the administrator with an idea of flexible budget/workload relationships. In short, models forecasting nursing salary, as accurately as those described in this paper, can serve as a tool to allow administrators to employ a flexible hospital budget tied to workload projections.

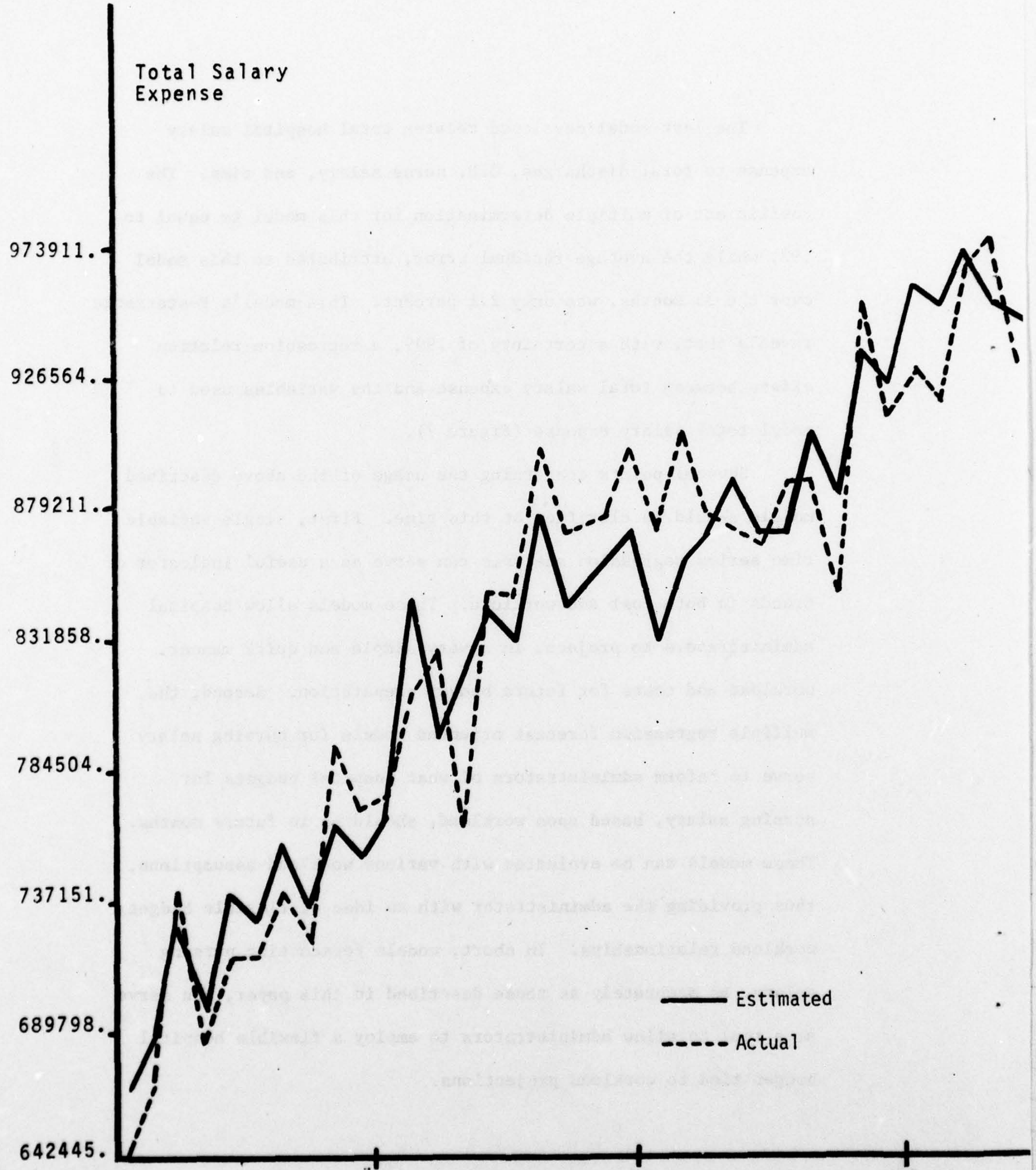


Figure 7. Total Salary vs. Time

CONTINUING RESEARCH

This research is currently being expanded into the remaining wards of the hospital. The results to date have been both encouraging to us and beneficial to the hospital. We are currently working with the nursing supervisors on each ward to carefully analyze and evaluate those data points that are beneath the regression line to further our understanding of the cost savings we witnessed during these "efficient" months. Our mutual goal is to obtain an understanding of both the low-cost and high-cost months, so that we might better capitalize on the observed efficiencies, modify our data to allow for any irregularities, and develop a new model which would give the hospital the necessary salary budget projections based upon anticipated efficiencies. This fine-tuned model would provide an even greater predictor of salary costs as a function of workload.

The question of predicting the demand side of the model remains a perplexing one for most hospital administrators. In order to alleviate this problem, we are currently developing a multiple regression model for the Colorado Springs area based on population trends, age pattern, level of care, and occupancy rates. This model should allow the hospital staff to better project the future level of services and to predict what the individual hospital can expect in terms of patient load and case mix.

CONCLUSION

The cost prediction models that were developed provide the nursing supervisor with monthly and yearly nursing salary predictions for two major wards as a function of workload. For any given level of monthly workload, costs can be estimated based upon historical levels of efficiencies. Costs that fall within the predicted levels can be considered normal, and management can focus its attention on the areas that are outside the expected behavior. Such issues as inflation, nurse skill mix, intensity of care, quality of care, and improvements in efficiency can be considered as possible justification for the observed deviations. The models developed are currently being used by the hospital studied, and the results obtained so far suggest that they are far superior to any existing management procedures. They provide the nursing supervisor with a technique to allow her to more effectively budget her costs using a flexible budget, and to control her operation by concentrating her attention to abnormal deviations in salary costs.

APPENDIX A

Total Hospital Salary Expense

NOTE: Appendix A describes, in detail, the multi-variable regression equation used to model Total Hospital Salary Expense.

The Model

Dependent Variable
Total Salary Expense, (Y)

Independent Variables
Total Discharges, (X_1)
OB Nurse Salary, (X_2)
Time, (X_3)

Total salary expense can be expressed in terms of the following mathematical expression:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon_i$$

A regression of this model yielded the following coefficients:

$$Y = 347{,}233 + 45.4\ X_1 + 14.8\ X_2 + 6938.2\ X_3 + \varepsilon_i$$

NOTE: ε_i = The regression error term associated with the prediction of each particular true value of Y.

NOTE: The average values for X_1, X_2, and X_3 respectively are 1400, 18000, and 19. These values tend to support the values found

for β_1, β_2 and β_3. The average values taken with the regression coefficients denote the fact that each of our variables is important to the prediction of Y, and no one variable overpowers the others.

Statistics

A. $R^2 = .92$

R^2 is the Coefficient of Multiple Determination. The use of the predictors X_1, X_2, and X_3 explains the total variation in Y by the proportion indicated over the variation that would be explained were $\overline{Y}$ the only predictor. 92.16% of the variation in Total Salary Expense is explained by the above stated regression model.

B. $R_a^2 = .91$

R_a^2 is the adjusted Coefficient of Multiple Determination. As independent variables are added to any regression model, R^2 must increase due to effects explained by the mathematical representation of Y-value dispersion.

$$SSTO = SSR + SSE$$

SSTO = Total Dispersion

SSR = Dispersion explained by the model

SSE = Dispersion not explained by the model

SSE must decrease with the addition of independent variables, while SSTO is constant for a given set of responses. The adjusted coefficient of multiple determination is defined so that it may actually become smaller when independent variables are added to the model. The adjusted R^2 will show the <u>true</u> contribution of the independent variables to the model's explanatory powers.

C. F-Test Statistic

The F-Statistic addresses the question, "Does a relationship exist between the dependent variable, Total Hospital Salary Expense (Y), and the set of independent variables (X_1, X_2, and X_3)?"

or: $H_0 : \beta_1 = \beta_2 = \beta_3 = 0$

H_1 : At least one β_i not equal to 0.

F-critical for a confidence level of .999 is 7.05.

The model's F-statistic is

$$F^4_{35} = 121.48$$

Since 121.48 is greater than 7.05, it may be concluded with a certainty of 99.9% that a regression relation between the independent and dependent variables exists. The hypothesis H_1 is, on the basis of this test, accepted and the null rejected.

D. T-Statistic

The T-Statistic answers the following question for each independent variable: "Should the independent variable be allowed to remain in this model given that all other independent variables are in the model?" (i.e., "what is the marginal contribution of each independent variable?")

or: $H_0 : \beta_i = 0$; given all other β_i are present in the model.

$H_1 : \beta_i$ not equal to 0; given all other β_i are present in the model.

Variable	T-Statistic	T-Critical	Confidence Level
Total Discharge	.855	.854	.600
O.B. Nurse Salary	4.72	3.64	.999
Time	10.370	3.646	.999

For each of the above referenced variables, the T-statistic is greater than T-critical. It may be concluded, at the appropriate confidence level, that β_i is not equal to 0, given all other β_i are present in the model, and that each independent variable is making an important contribution to the model.

E. Durbin-Watson Test

The Durbin-Watson test allows one to gauge the presence of autocorrelation in the model and is defined as:

$$D = 2 - 2\rho.$$

NOTE: The basic regression model assumes the error terms (ε_i) are either uncorrelated random variables or independent normal random variables. The model discussed in this appendix involves time series data. For this type of data, the assumption of uncorrelated or independent error terms is often not appropriate. Error terms which are correlated over time are said to be autocorrelated and result from the omission of key variables from the model. When the time-ordered effects of such "missing" key variables are positively correlated, the error terms in the regression model will tend to be positively autocorrelated, since the error terms

include effects of the missing variables. Autocorrelation inflates the T- and F-test statistics so as to make these tests no longer strictly applicable.

The Durbin-Watson test uses the value of the autocorrelation parameter ρ to test for the presence of autocorrelation. (This is analogous to β_i in the regular model, but here it is a "β" for the error terms (ε_i).) If $\rho = 1$ then it may be concluded that the error terms are not independent and are autocorrelated.

or: $H_0 : \rho = [1]$

$H_1 : \rho$ not equal to [1]

This test will only prove conclusively that autocorrelation exists. The test may, however, fail to indicate the presence of autocorrelation. For the model presented in this appendix, the Durbin-Watson test is equal to 1.58 and is greater than the upper bound of the Durbin-Watson critical test range. It may be concluded that H_0 is to be rejected. At a confidence level of .99, it is concluded that the presence of autocorrelation is not indicated in this model.

F. Multicollinearity

NOTE: Multicollinearity exists when the model's independent variables are correlated among themselves, and no unique sum of squares exists that can be ascribed to an independent variable as reflecting that independent variable's effect in reducing the total variation of the dependent variable. As a result, the

individual estimated regression coefficients (β_i) may not be statistically significant. The fact that some or all independent variables are correlated among themselves does not, in general, inhibit the ability to obtain a good fit, nor does it tend to effect inferences about mean responses or predictions of new observations. It is interesting to note that high correlations among independent variables are frequently found in economic and business analysis.

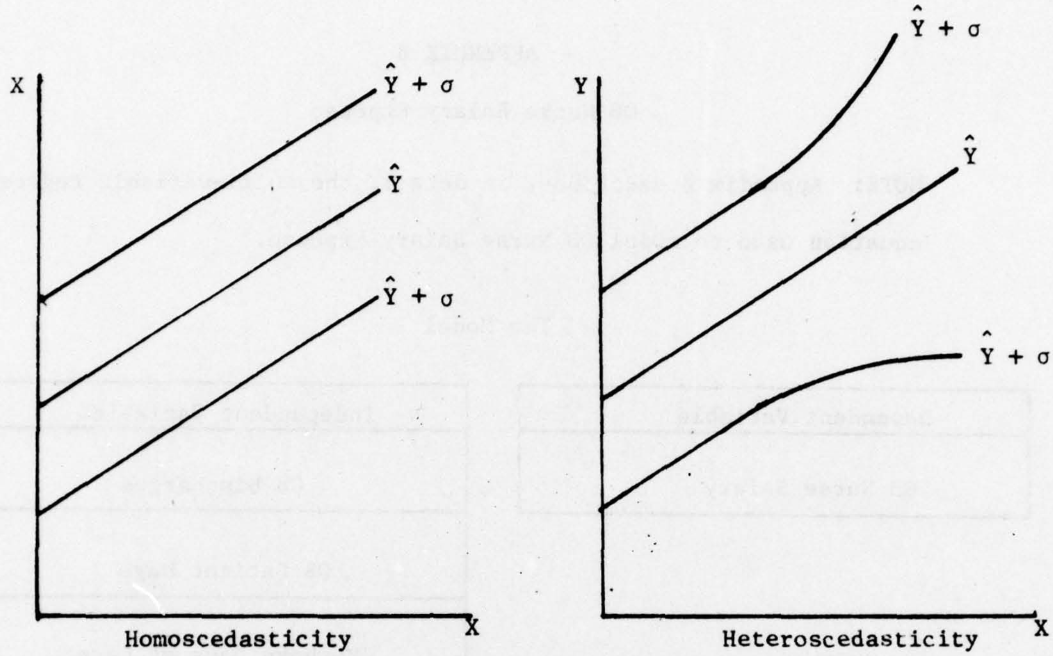
Simple Correlation Matrix

Variable	Total Discharges	OB Nurse Salary	Time
Total Discharges	1.00000	-.3741100	-.6736300
OB Nurse Salary	.37411	1.00000	+.758600
Time	- .6736300	.5758600	1.00000

None of the values shown in the correlation matrix indicate Multicollinearity to be a problem. This fact is particularly true in light of an R^2 value of .92.

G. Homoscedasticity

NOTE: The problem of heteroscedasticity results when the variance of the error terms is not constant over all observations. (Homoscedasticity is the condition present when the error variances are constant.)



When heteroscedasticity is present, the estimates are unbiased and consistent; they are also no longer minimum variance unbiased estimaters.

Conclusion

The three variable regression model presented in this appendix is a statistically sound model for Total Hospital Salary Expense. The computer printout shown on page 56 demonstrates the model's ability to predict Total Hospital Salary Expense based upon Total Discharges, OB Nurse Salary, and Time. An important indicator of this model's ability to forecast Total Salary Expense is an average percent residual error of less than 2.5% over the 35 month period of model evaluation.

APPENDIX B

OB Nurse Salary Expense

NOTE: Appendix B describes, in detail, the multi-variable regression equation used to model OB Nurse Salary Expense.

The Model

Dependent Variable
OB Nurse Salary

Independent Variables
OB Discharges
OB Patient Days
Newborn Days of Care
Time

OB Nurse Salary Expense can be expressed in terms of the following mathematical expression:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon_i$$

A regression of this model yielded the following coefficients:

$$Y = 10166.4 + (-12)\,X_1 + 6.46\,X_2 + 9.58\,X_3 + 94.2\,X_4 + \varepsilon_i$$

NOTE: Average values for X_1, X_2, X_3, and X_4 respectively are 130, 200, 300, and 17. These values tend to support the values found for β_1, β_2, β_3, and β_4. The average values taken with the regression coefficients denote the fact that each of our variables is important to the prediction of Y, and yet no one variable is overpowering.

Statistics

A. $R^2 = .73$

R^2, the Coefficient of Multiple Determination, indicates that 73.5% of the variation in OB Nurse Salary Expense is explained by the above stated regression model.

B. $R_a{}^2 = .70$

The adjusted coefficient of multiple determination shows the true contribution of the independent variables to the model's explanatory powers. $R_a{}^2$ indicates that 70.5% of the variation in OB Nurse Salary Expense is explained by the above stated regression model.

C. F-Test Statistic

$H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0.$

H_1 : At least one β_i is not equal to 0.

F-critical for a confidence level of .999 is 6.12.

This model's F-statistic is

$$F^5_{35} = 20.88$$

Since 20.88 is greater than 6.12, it may be concluded that with a certainty of 99.9%, a regression relation between the independent and dependent variables exists. The hypothesis H_1 is, on the basis of this test, accepted and the null rejected.

D. T-Statistic

$H_0 : \beta_i = 0$; given all other β_i are present in the model.

$H_i : \beta_i$ not equal to 0; given all other β_i are present in the model.

Variable	T-Statistic	T-Critical	Confidence Level
O.B. Discharges	-1.87	1.697	.90
O.B. Patient Days	4.32	3.646	.999
Newborn Days of Care	2.33	2.042	.95
Time	2.54	2.48	.98

For each of the above referenced variables, the T-statistic is greater than the value of T-critical. Thus, one may conclude at the appropriate confidence level, that β_i does not equal 0, given all other β_i are present in the model, and that each independent variable is making an important contribution.

E. Durbin-Watson Statistic

The Durbin-Watson test uses the value of the autocorrelation parameter ρ to test for the presence of autocorrelation.

$H_0 : \rho = [1]$

$H_1 : \rho$ not equal to [1]

This test will only prove conclusively that autocorrelation exists. The test may, however, fail to indicate the presence of autocorrelation. For the model presented in this appendix, the Durbin-Watson statistic is equal to 2.78 and is greater than the upper bound of the Durbin-Watson critical test range. It may be concluded

that H_0 is to be rejected. At a confidence level of .99, it is concluded that the presence of autocorrelation is not indicated in this model.

F. Multicollinearity

Simple Correlation Matrix

OB Discharges	OB Patient Days	Newborn Days of Care	Time	
1.000	.1656	-.3952	-.5948	OB Discharges
.1056	1.0000	-.4659	.6655	OB Patient Days
-.3952	-.4659	1.0000	-.7425	Newborn Days of Care
.5948	.6655	-.7425	1.0000	Time

None of the values shown in the Simple Correlation Matrix indicate multicollinearity to be a problem. This fact is particularly true in light of an R^2 value of .73.

G. Homoscedasticity

A review of the error terms presented on page 55 shows the regression errors to be characterized by the condition of homoscedasticity. The presence of heteroscedasticity is not indicated. Thus, the estimates used in this model are assumed to be minimum variance.

Conclusion

The four variable regression model presented in this appendix is a statistically sound model for OB Nurse Salary Expense. The computer printout listed on page 52 demonstrates this model's ability to predict OB Nurse Salary Expense as a function of OB Discharges, OB Patient Days, Newborn Days of Care, and Time. An important indicator of this model's ability to forecast OB Nurse Salary Expense is an average percent residual error of 3.7% over the 35 month period of model evaluation. This model has been employed to forecast OB Nurse Salary Expense one month into the future based upon projected workloads. The model has been accurate within 5% of actual OB Nurse Salary Expense for these forecasts.

APPENDIX C

Medical/Surgical Nurse Salary Expense

NOTE: Appendix C describes, in detail, the multi-variable regression equation used to model Medical/Surgical Nurse Salary Expense.

The Model

Dependent Variable
Medical/Surgical Nurse Salary Expense

Independent Variables
Time
Medical/Surgical Admissions
Time Cubed

Medical/Surgical Nurse Salary Expense can be expressed in terms of the following mathematical expression:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon_i$$

A regression of this model yielded the following coefficients:

$$Y = 110079 + 3135.1\, X_1 + 55.5\, X_2 + (-1.1) X_3 + \varepsilon_i$$

NOTE: Average values for X_1, X_2, and X_3 respectively are 18, 1200, and 5800. These values tend to support the values found for β_1, β_2, and β_3. The average values taken with the regression coefficients denote the fact that each of our variables is important to the prediction of Y, and yet no one variable is overpowering.

Statistics

A. $R^2 = .63$

R^2, the Coefficient of Multiple Determination, indicates that 63.40% of the variation in OB Nurse Salary Expense is explained by the above stated regression model.

B. $R_a{}^2 = .60$

The adjusted coefficient of multiple determination shows the true contribution of the independent variables to the model's explanatory powers. $R_a{}^2$ indicates that 60.26% of the variation in Medical/Surgical Nurse Salary Expense is explained by the above stated regression model.

C. F-Test Statistic

$H_0 : \beta_1 = \beta_2 = \beta_3 = 0$

H_i : At least one β_i not equal to 0.

F-critical for a confidence level of .999 is 7.05.

This model's F-statistic is

$$F^4_{35} = 20.21$$

Since 20.21 is greater than 7.05, it may be concluded that with a certainty of 99.9%, a regression relation between the independent and dependent variables exists. The hypothesis H_1 is, on the basis of this test, accepted and the null rejected.

D. T-Statistic

$H_0 : \beta_i = 0$; given all other β_i are present in the model.

$H_i = \beta_i$ not equal to 0; given all other β_i are present in the model.

Variable	T-Statistic	T-Critical	Confidence Level
Time	6.977	3.551	.999
Medical/Surgical Admissions	2.673	2.457	.98
Time Cubed	-4.763	3.551	.999

For each of the above referenced variables, the T-statistic is greater than the value of T-critical. Thus, one may conclude at the appropriate confidence levels that β_i does not equal 0, given all other β_i are present in the model, and that each independent variable is making an important contribution.

E. Durbin-Watson Statistic

The Durbin-Watson test uses the value of the autocorrelation parameter ρ to test for the presence of autocorrelation.

$H_0 : \rho = [1]$

$H_1 : \rho$ does not equal [1]

This test will only prove conclusively that autocorrelation exists. The test may, however, fail to indicate the presence of autocorrelation. For the model presented in this appendix, the Durbin-Watson statistic is equal to 1.04 and is greater than the lower bound of the Durbin-Watson critical test range. It may not be

concluded that autocorrelation is present within this model. The test results show that the presence or lack of autocorrelation in this model is indeterminate.

F. Multicollinearity

Simple Correlation Matrix

	Time	Medical/Surgical Admissions	Time Cubed
Time	1.0000	-.8542	.9192
Medical/ Surgical Admissions	-.8589	1.0000	-.78550
Time Cubed	.9192	-.7855	1.0000

The values for Time and Time Cubed are highly correlated. This correlation is expected as the latter variable is derived from the former. None of the other values shown in the Simple Correlation Matrix indicate multicollinearity to be a problem.

G. Homoscedasticity

A review of the error terms presented on page 53 shows the regression errors to be characterized by the condition of homoscedasticity. The presence of heteroscedasticity is not indicated. The estimates used in this model are assumed to be minimum variance.

Conclusion

The three variable regression model presented in this appendix is a statistically sound model for Medical/Surgical Nurse Salary Expense. The computer printout listed on page 46 demonstrates the model's ability to predict Medical/Surgical Nurse Salary as a function of Time and Medical/Surgical Admissions. An important indicator of this model's ability to forecast Medical/Surgical Nurse Salary Expense is an average percent residual error of 3.5% over the 35 month period of model evaluation.

APPENDIX D

```
++++++++++++++++++++++++++++++++++++++++++++ DETROIT REGRESSION ANALYSIS ++++++++++++++++++++++++++++++++++++++++++++

REGRESSION SERIES TITLE:  HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY**MS**

      ----- FOLLOWING REGRESSION STATISTICS DERIVED FROM  39 OBS. INDEXED FROM   1 TO  39 -----
   DEPENDENT VARIABLE:  INDEX   LAG   TITLE
                          1      0    MEDICAL AND SURGICAL NURSE SALARY EXPENSE
INDEPENDENT VARIABLES;  INDEX   LAG   TITLE
                          2      0    TIME FACTOR BETA #1
                          3      0    MEDICAL AND SURGICAL ADMISSIONS
                          4      0    TIME FACTOR BETA #1 CUBED

                          INTERCEPT TERM:  ALPHA =    110079.
        COEFFICIENT OF MULTIPLE DETERMINATION:  R-SQUARED = 0.634041
ADJUSTED COEFFICIENT OF MULTIPLE DETERMINATION:  ADJ R-SQUARED = 0.602673    DEGREES OF FREEDOM:   3 (NUMERATOR),  35 (DENOMINATOR)
                                  F-TEST STATISTIC:  F =     20.2130  DEGREES OF FREEDOM:   3 (NUMERATOR),  35 (DENOMINATOR)
                             DURBIN-WATSON STATISTIC:  D =     1.0381
                  ESTIMATED RHO (FOR AUTOCORRELATION):  RHO =     0.435458
                       RESIDUAL MEAN SQUARE:  SIGMA SQUARED =     .107740E+09

VARIABLE        ESTIMATED                                                          COEFFICIENT OF          AVERAGE VALUE
INDEX        COEFFICIENT VALUE       STANDARD ERROR        STUDENT T RATIO     INCREMENTAL CONTRIBUTION     OF VARIABLE
   2             3135.16               453.409                6.91464               0.759840               20.0000
   3             55.5449               20.6195                2.69376               0.414394               1175.54
   4            -1.15070               0.241562              -4.76356              -0.627157               15600.0
   1                                                                  DEPENDENT VARIABLE AVERAGE VALUE:    220126.
                                                                                     STANDARD ERROR:      16467.0

ANALYSIS OF VARIANCE STATISTICS:
F-STATISTIC IS BASED ON THE ADDITIONAL REGRESSION SUM OF SQUARES                          DEGREES OF FREEDOM:
                ATTRIBUTABLE TO THE VARIABLES INDEXED:           F-STATISTIC:      (NUMERATOR)       (DENOMINATOR)
                                                    3  4            14.72               2                 35
                                                       4            22.69               1                 35
SIMPLE CORRELATION MATRIX:
            2            3            3
VAR ************ ************ ************
 2    1.0000      -0.85892      0.91925
 3   -0.85892      1.0000      -0.78550
 4    0.91925     -0.78550      1.0000

VARIANCE-COVARIANCE MATRIX:
            2            3            4
VAR ************ ************ ************
 2   .23556E+06    5251.4      -84.519
 3    5251.4       425.18      -0.10017
 4   -5-.519      -0.10017     .58352E-01
```

IN ACCORDANCE WITH CONTROL CARD(S) NO. 7 - 7, THE VALUES OF THE FOLLOWING VARIABLE(S) WILL BE PRINTED:

INDEX OF VARIABLE = 1, VARIABLE TITLE: MEDICAL AND SURGICAL NURSE SALARY EXPENSE
INDEX OF VARIABLE = 2, VARIABLE TITLE: TIME FACTOR BETA #1
INDEX OF VARIABLE = 3, VARIABLE TITLE: MEDICAL AND SURGICAL ADMISSIONS
INDEX OF VARIABLE = 4, VARIABLE TITLE: TIME FACTOR BETA #1 CUBED

VARIABLE INDEX NUMBER:

OBS NO.	1	2	3	4
1	198953.00	1.0000000	1442.0000	1.0000000
2	199542.00	2.0000000	1325.0000	8.0000000
3	194318.00	3.0000000	1343.0000	27.000000
4	192339.00	4.0000000	1407.0000	64.000000
5	188024.00	5.0000000	1197.0000	125.00000
6	194207.00	6.0000000	1205.0000	216.00000
7	213614.00	7.0000000	1424.0000	343.00000
8	191115.00	8.0000000	1261.0000	512.00000
9	219394.00	9.0000000	1381.0000	729.00000
10	207054.00	10.000000	1350.0000	1000.0000
11	218906.00	11.000000	1408.0000	1331.0000
12	215216.00	12.000000	1406.0000	1728.0000
13	233735.00	13.000000	1400.0000	2197.0000
14	232195.00	14.000000	1296.0000	2744.0000
15	215267.00	15.000000	1271.0000	3375.0000
16	216794.00	16.000000	1230.0000	4096.0000
17	226573.00	17.000000	1060.0000	4913.0000
18	215196.00	18.000000	1134.0000	5832.0000
19	230934.00	19.000000	1165.0000	6859.0000
20	236825.00	20.000000	1085.0000	8000.0000
21	243291.00	21.000000	1233.0000	9261.0000
22	245391.00	22.000000	1193.0000	10648.000
23	239444.00	23.000000	1075.0000	12167.000
24	247330.00	24.000000	1206.0000	13824.000
25	235397.00	25.000000	1169.0000	15625.000
26	240007.00	26.000000	1195.0000	17576.000
27	225519.00	27.000000	1058.0000	19683.000
28	232263.00	28.000000	1037.0000	21952.000
29	220398.00	29.000000	1031.0000	24389.000
30	220636.00	30.000000	927.00000	27000.000
31	210167.00	31.000000	1056.0000	29791.000
32	199573.00	32.000000	995.00000	32768.000
33	217961.00	33.000000	1041.0000	35937.000
34	215913.00	34.000000	956.00000	39304.000
35	229143.00	35.000000	938.00000	42875.000
36	225095.00	36.000000	1058.0000	46656.000
37	235294.00	37.000000	937.00000	50653.000
38	236592.00	38.000000	1105.0000	54872.000
39	221320.00	39.000000	932.00000	59319.000

```
------------------------------ IMAGES OF DATA CARDS SUBMITTED FOR DETROIT REGRESSION ANALYSIS ------------------------------------

NOTE:  THE NEXT  39 DATA-SET OBSERVATIONS BELOW WILL BE INTERPRETED BY THE FOLLOWING CONTROL CARD:
RANDATA 00 PRINT 03 VAR 039 OBS DATAFMT(I7,I3,I5)
        ------ -- ---  ---------------------------------------
              (** INDICATE PROPER COLUMNS FOR ENTERING PARAMETERS)

 185959  1 1342                                                                   1
 199542  2 1325                                                                   2
 193318  3 1340                                                                   3
 192339  4 1407                                                                   4
 188024  5 1197                                                                   5
 194207  6 1205                                                                   6
 213614  7 1429                                                                   7
 191118  8 1261                                                                   8
 214394  9 1381                                                                   9
 207054 10 1350                                                                  10
 214906 11 1409                                                                  11
 218216 12 1406                                                                  12
 233745 13 1400                                                                  13
 232195 14 1295                                                                  14
 215267 15 1271                                                                  15
 210798 16 1230                                                                  16
 226573 17 1060                                                                  17
 215150 18 1139                                                                  18
 230934 19 1165                                                                  19
 235825 20 1085                                                                  20
 243241 21 1233                                                                  21
 245341 22 1103                                                                  22
 234444 23 1075                                                                  23
 247330 24 1205                                                                  24
 235397 25 1169                                                                  25
 240007 26 1196                                                                  26
 228518 27 1055                                                                  27
 232263 28 1037                                                                  28
 220398 29 1031                                                                  29
 224636 30  927                                                                  30
 210167 31 1056                                                                  31
 199573 32  985                                                                  32
 217961 33 1041                                                                  33
 215913 34  966                                                                  34
 229143 35  935                                                                  35
 226093 36 1059                                                                  36
 235294 37  937                                                                  37
 236592 38 1106                                                                  38
 221320 39  932                                                                  39
.............................................................. TOTAL NUMBER OF DATA CARDS FOR REGRESSION INPUT:      39
  3 VAR IN DATA-SET NO.    1 ABOVE ENTERED INTO COMPUTER UNDER FORMAT (I7,I3,I5)

              CONTROL CARD BEING PROCESSED:    PROTITL HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY****

              CONTROL CARD BEING PROCESSED:    VARNAME 01MEDICAL AND SURGICAL NURSE SALARY EXPENSE

              CONTROL CARD BEING PROCESSED:    VARNAME 02TIME FACTOR BETA #1

              CONTROL CARD BEING PROCESSED:    VARNAME 03MEDICAL AND SURGICAL ADMISSIONS

              CONTROL CARD BEING PROCESSED:    VARNAME 04TIME FACTOR BETA #1 CUBED

              CONTROL CARD BEING PROCESSED:    CALDATA CODE = 23, NEW INDEX K =   4, I =   2, C = 3.0
                                                                                         J = --
                                                                                         C = .......
INDEX K =  4, NEW VARIABLE NAME IS:  TIME FACTOR BETA #1 CUBED
INDEX I =  2, OLD VARIABLE NAME IS:  TIME FACTOR BETA #1
CONSTANT C =      3.000000
CALDATA CODE 23:  X(K) = X(I) **          3.0000000

              CONTROL CARD BEING PROCESSED:    PRINTIT 04 VARS INDEXED 01 02 03 04
```

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```
                        DETRUTH ECONOMETRIC PACKAGE    VERSION  06/20/77  13:27

DETRUTH REGRESSION ANALYSIS PARAMETER LIMITS FOR THIS RUN ARE:
250 = MAXIMUM LIMIT FOR OBSERVATIONS,
 51 = MAXIMUM LIMIT FOR SUM OF RAW AND CALCULATED VARIABLES,
 50 = MAXIMUM LIMIT FOR NUMBER OF INDEPENDENT VARIABLES USED IN A REGRESSION ANALYSIS.

------------------------------- IMAGES OF CONTROL CARDS SUBMITTED FOR DETRUTH REGRESSION ANALYSIS -------------------------------
        10        20        30        40        50        60        70        80        (CARD NUMBER)

PROTITL HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY**MS**                                       1
VARNAME 01MEDICAL AND SURGICAL NURSE SALARY EXPENSE                                             2
VARNAME 02TIME FACTOR BETA #1                                                                   3
VARNAME 03MEDICAL AND SURGICAL ADMISSIONS                                                       4
VARNAME 04TIME FACTOR BETA #1 CUBED                                                             5
COMPUTE 04 = 02 ** 3.0                                                                          6
CALDATA CODE = 23, NEW INDEX <= 4, I = 2, C = 3.0                                               6* GENERATED BY COMPUTE CARD *
PRINTIT 04 VARS INDEXED 01 02 03 04                                                             7
XYPLOT WITH X = 02                                                                              8
REGRESS DEP 01, IND 02 03 04                                                                    9
RANDATA 30 PRINT 03 VAR 039 OBS DATAFMT(17,13,15)                                              10
END                                                                                            11
.................................................................... TOTAL NUMBER OF DETRUTH CONTROL CARDS SUBMITTED:  11
```

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```
WORKFILE: FORPAULA (12/14/77)                                   2103 PM WEDNESDAY, DECEMBER 14, 1977
   100   PROTITL HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY**MS**
   200   VARNAME 01MEDICAL AND SURGICAL NURSE SALARY EXPENSE
   300   VARNAME 02TIME FACTOR BETA #1
   400   VARNAME 03MEDICAL AND SURGICAL ADMISSIONS
   500   VARNAME 04TIME FACTOR BETA #1 CUBED
   600   COMPUTE 04 = 02 ** 3.0
   700   PRINTIT 04 VARS INDEXED 01 02 03 04
   800   XYPLOT WITH X = 02
   900   REGRESS DEP 01, IND 02 03 04
  1000   RAWDATA DC PRINT 03 VAR 039 OBS DATAFMT(I7,I3,I5)
  1100    198559  1 1442
  1200    199542  2 1329
  1300    194318  3 1340
  1400    192359  4 1407
  1500    188024  5 1197
  1600    194207  6 1209
  1700    213614  7 1429
  1800    191118  8 1261
  1900    214394  9 1381
  2000    207024 10 1350
  2100    214906 11 1408
  2200    218216 12 1406
  2300    233735 13 1400
  2400    232195 14 1296
  2500    215207 15 1271
  2600    216774 16 1230
  2700    226573 17 1060
  2800    215186 18 1134
  2900    230934 19 1165
  3000    236823 20 1085
  3100    243291 21 1232
  3200    245391 22 1103
  3300    239444 23 1075
  3400    247330 24 1206
  3500    235397 25 1169
  3600    240007 26 1196
  3700    228518 27 1058
```

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FROM COPY FURNISHED TO DDC

```
3800    232263 28 1037
3900    220378 29 1031
4000    224636 30  927
4100    210107 31 1056
4200    199573 32  988
4300    217561 33 1041
4400    215913 34  968
4500    229143 35  938
4600    228093 36 1058
4700    235234 37  937
4800    236542 38 1108
4900    221320 39  932
5000    END
```

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** DETRUTH REGRESSION ANALYSIS **

REGRESSION SERIES TITLE: HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY**OB**TOTAL SALARY**

----- FOLLOWING REGRESSION STATISTICS DERIVED FROM 35 OBS. INDEXED FROM 1 TO 35 -----

DEPENDENT VARIABLE:	INDEX	LAG	TITLE
	1	0	OB NURSE SALARY EXPENSE

INDEPENDENT VARIABLES:	INDEX	LAG	TITLE
	2	0	OB DISCHARGES
	4	0	OB PATIENT DAYS
	6	0	NEWBORN DAYS OF CARE
	5	0	TIME FACTOR BETA=01

INTERCEPT TERM: ALPHA = 10166.4

COEFFICIENT OF MULTIPLE DETERMINATION: R-SQUARED = 0.735741

ADJUSTED COEFFICIENT OF MULTIPLE DETERMINATION: ADJ R-SQUARED = 0.700506 DEGREES OF FREEDOM: 4 (NUMERATOR), 30 (DENOMINATOR)

F-TEST STATISTIC: F = 20.0812 DEGREES OF FREEDOM: 4 (NUMERATOR), 30 (DENOMINATOR)

DURBIN-WATSON STATISTIC: D = 2.7869

ESTIMATED RHO (FOR AUTOCORRELATION): RHO = -0.395014

RESIDUAL MEAN SQUARE: SIGMA SQUARED = 906470.

VARIABLE INDEX	ESTIMATED COEFFICIENT VALUE	STANDARD ERROR	STUDENT T RATIO	COEFFICIENT OF INCREMENTAL CONTRIBUTION	AVERAGE VALUE OF VARIABLE
2	-12.0604	6.43818	-1.87326	-0.323606	138.571
4	6.46003	1.49203	4.32970	0.620136	666.800
6	9.58229	4.09511	2.33993	0.392863	347.657
5	94.2443	37.0217	2.54565	0.421473	22.0000
1				DEPENDENT VARIABLE: AVERAGE VALUE:	10207.5
				STANDARD ERROR:	1739.73

ANALYSIS OF VARIANCE STATISTICS:

F-STATISTIC IS BASED ON THE ADDITIONAL REGRESSION SUM OF SQUARES

ATTRIBUTABLE TO THE VARIABLES INDEXED:	F-STATISTIC:	DEGREES OF FREEDOM: (NUMERATOR)	(DENOMINATOR)
4 6 5	27.83	3	30
6 5	3.803	2	30
5	6.480	1	30

SIMPLE CORRELATION MATRIX:

VAR	2	4	6	5
2	1.0000	0.10562	-0.39529	0.59481
4	0.10562	1.0000	-0.46599	0.66551
6	-0.39529	-0.46599	1.0000	-0.74258
5	0.59481	0.66551	-0.74258	1.0000

VARIANCE-COVARIANCE MATRIX:

VAR 2 4 6 5

4	4.7184	2.2261	-0.68757	-37.330
6	-3.4244	-0.68757	16.770	87.839
5	-154.06	-37.330	87.839	1370.6

LISTING AND PLOT OF REGRESSION RESIDUALS

OBS. NO.	ACTUAL Y FROM DATA	ESTIMATED Y	REGRESSION RESIDUALS	OBS. NO.
1	14627.0	16115.4	-1488.37	1
2	15875.0	16100.1	-225.111	2
3	17447.0	16840.9	606.110	3
4	18800.0	19202.5	-402.531	4
5	17221.0	16578.0	642.969	5
6	16308.0	16539.9	-231.854	6
7	17492.0	16050.8	1441.23	7
8	15481.0	16345.1	-864.089	8
9	17065.0	16402.7	662.265	9
10	15866.0	16328.0	-462.035	10
11	16988.0	16918.0	70.0289	11
12	21420.0	19599.9	1820.08	12
13	15782.0	16501.5	-719.457	13
14	18983.0	18622.1	360.936	14
15	20131.0	19494.7	636.301	15
16	18982.0	20059.9	-1077.94	16
17	21321.0	20414.9	906.060	17
18	18991.0	19354.5	-363.487	18
19	19502.0	20160.9	-658.928	19
20	19962.0	19588.4	373.582	20
21	16384.0	17965.3	-1581.32	21
22	18109.0	17932.3	176.733	22
23	18598.0	19062.1	-464.069	23
24	19192.0	18344.0	847.996	24
25	17964.0	18404.7	-440.675	25
26	17343.0	16797.8	545.156	26
27	18972.0	19543.4	-571.398	27
28	16920.0	17648.5	-728.477	28
29	19768.0	19104.5	663.494	29
30	18474.0	18801.0	-327.029	30
31	20604.0	19538.8	1065.22	31
32	19881.0	20416.7	-535.719	32
33	20530.0	18329.9	2200.14	33
34	19133.0	20151.4	-1018.40	34
35	18545.0	19402.4	-857.421	35

PLOT OF RESIDUALS

RANGE OF PLOT MIN. = -2200.14 MAX. = 2200.14

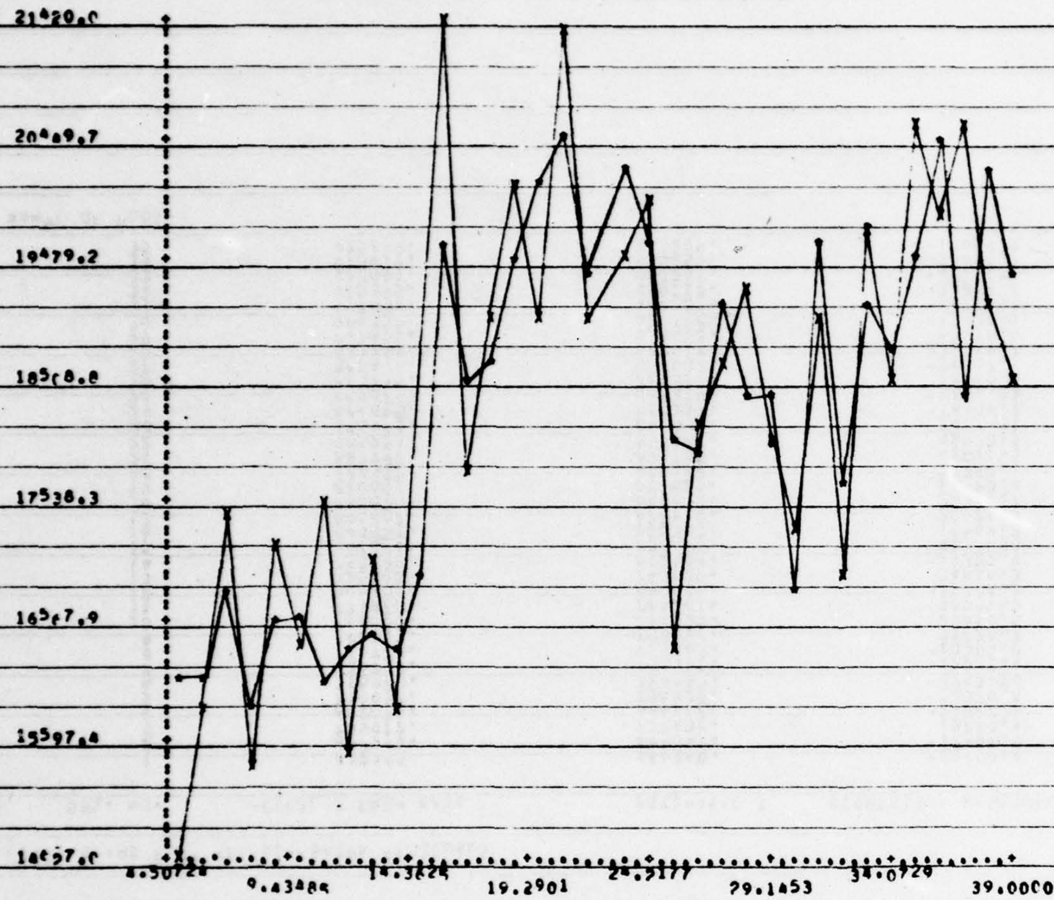
++ DETRLTH REGRESSION X-Y PLOT ++

REGRESSION SERIES TITLE: HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY..OR..TOTAL SALARY..

REGRESSION EQUATION TITLE:

Y VARIABLE # 1 TITLE: OR NURSE SALARY EXPENSE

(Y'S PLOTTED WITH AN X) Y ESTIMATES PLOTTED WITH AN *)

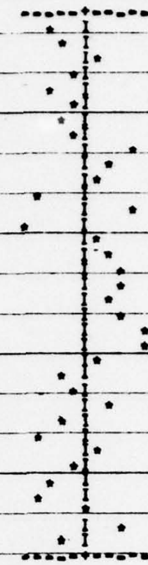


X VARIABLE # 5 TITLE: TIME FACTOR BETA=01

LISTING AND PLOT OF REGRESSION RESIDUALS

OBS. NO.	ACTUAL Y FROM DATA	ESTIMATED Y	REGRESSION RESIDUALS	OBS. NO.
1	642445.	666248.	-23803.4	1
2	667246.	684648.	-17402.0	2
3	739912.	727138.	12773.6	3
4	682094.	694117.	-12022.8	4
5	710957.	735928.	-24970.8	5
6	715920.	724663.	-8743.26	6
7	734719.	753371.	-18652.4	7
8	718724.	729089.	-10365.0	8
9	790215.	756493.	31721.7	9
10	768063.	747405.	20658.5	10
11	773970.	764161.	9808.50	11
12	808234.	840858.	-32624.1	12
13	825066.	790600.	34466.3	13
14	763102.	812404.	-49301.9	14
15	846636.	837478.	9157.88	15
16	843551.	825582.	17969.2	16
17	895567.	872940.	22626.9	17
18	865020.	840640.	24379.7	18
19	876054.	857626.	18428.3	19
20	897392.	870162.	27230.1	20
21	867782.	826765.	41016.5	21
22	905296.	856667.	48628.5	22
23	875966.	868039.	7927.21	23
24	866645.	883111.	-16466.2	24
25	858674.	868310.	-9636.04	25
26	883745.	866577.	17168.4	26
27	882696.	904033.	-21337.1	27
28	843444.	882014.	-38569.7	28
29	947861.	934695.	13166.5	29
30	909352.	922788.	-13436.1	30
31	927531.	954235.	-26704.3	31
32	915395.	950213.	-34817.7	32
33	963011.	967287.	-4275.71	33
34	973911.	950250.	23660.7	34
35	925649.	943309.	-17659.9	35

PLOT OF RESIDUALS



RANGE OF PLOT MIN. = -49301.9 MAX. = 49301.9

++ DETRUTH REGRESSION ANALYSIS ++

REGRESSION SERIES TITLE: HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY..88..TOTAL SALARY..

----- FOLLOWING REGRESSION STATISTICS DERIVED FROM 35 OBS. INDEXED FROM 1 TO 35 -----

	INDEX	LAG	TITLE
DEPENDENT VARIABLE:	7	0	TOTAL SALARY EXPENSE
INDEPENDENT VARIABLES:	3	0	TOTAL DISCHARGES
	1	0	RN NURSE SALARY EXPENSE
	5	0	TIME FACTOR BETA=01

INTERCEPT TERM: ALPHA = 347233.

COEFFICIENT OF MULTIPLE DETERMINATION: R-SQUARED = 0.921609

ADJUSTED COEFFICIENT OF MULTIPLE DETERMINATION: ADJ R-SQUARED = 0.914023 DEGREES OF FREEDOM: 3 (NUMERATOR), 31 (DENOMINATOR)

F-TEST STATISTIC: F = 121.4849 DEGREES OF FREEDOM: 3 (NUMERATOR), 31 (DENOMINATOR)

DURBIN-WATSON STATISTIC: D = 1.5804

ESTIMATED RHO (FOR AUTOCORRELATION): RHO = 0.172256

RESIDUAL MEAN SQUARE: SIGMA SQUARED = .678054E+09

VARIABLE INDEX	ESTIMATED COEFFICIENT VALUE	STANDARD ERROR	STUDENT T RATIO	COEFFICIENT OF INCREMENTAL CONTRIBUTION	AVERAGE VALUE OF VARIABLE
3	45.5819	53.3174	0.854915	0.151769	1351.51
1	14.8449	3.14057	4.72683	0.641 84	18207.5
5	6938.24	669.071	10.3700	0.861046	22.0000
7				DEPENDENT VARIABLE AVERAGE VALUE:	831767.
				STANDARD ERROR:	88805.8

ANALYSIS OF VARIANCE STATISTICS:

F-STATISTIC IS BASED ON THE ADDITIONAL REGRESSION SUM OF SQUARES ATTRIBUTABLE TO THE VARIABLES INDEXED:

VARIABLES INDEXED	F-STATISTIC	DEGREES OF FREEDOM (NUMERATOR)	DEGREES OF FREEDOM (DENOMINATOR)
1 5	113.4	2	31
5	107.5	1	31

SIMPLE CORRELATION MATRIX:

VAR	3	1	5
3	1.0000	-0.37411	-0.67363
1	-0.37411	1.0000	0.57586
5	-0.67363	0.57586	1.0000

VARIANCE-COVARIANCE MATRIX:

VAR	3	1	5
3	2842.8	-3.8263	21559.
1	-3.8263	9.8632	-992.83
5	21559.	-992.83	.44766E+06

IN ACCORDANCE WITH CONTROL CARD(S) NO. 9 - 9, THE VALUES OF THE FOLLOWING VARIABLE(S) WILL BE PRINTED:

INDEX OF VARIABLE = 1, VARIABLE TITLE: OR NURSE SALARY EXPENSE
INDEX OF VARIABLE = 2, VARIABLE TITLE: OR DISCHARGES
INDEX OF VARIABLE = 3, VARIABLE TITLE: TOTAL DISCHARGES
INDEX OF VARIABLE = 4, VARIABLE TITLE: OR PATIENT DAYS
INDEX OF VARIABLE = 5, VARIABLE TITLE: TIME FACTOR BETA=01
INDEX OF VARIABLE = 6, VARIABLE TITLE: NEWBORN DAYS OF CARE

VARIABLE INDEX NUMBER:

OBS NO.	1	2	3	4	5	6
1	14627.000	133.00000	1474.0000	451.00000	5.0000000	435.00000
2	15875.000	136.00000	1319.0000	453.00000	6.0000000	466.00000
3	17447.000	138.00000	1567.0000	496.00000	7.0000000	467.00000
4	15400.000	109.00000	1377.0000	403.00000	8.0000000	375.00000
5	17221.000	143.00000	1549.0000	477.00000	9.0000000	439.00000
6	16308.000	138.00000	1447.0000	462.00000	10.000000	429.00000
7	17492.000	131.00000	1539.0000	415.00000	11.000000	391.00000
8	15481.000	115.00000	1509.0000	425.00000	12.000000	365.00000
9	17065.000	110.00000	1486.0000	410.00000	13.000000	365.00000
10	15866.000	119.00000	1481.0000	414.00000	14.000000	376.00000
11	16988.000	122.00000	1331.0000	437.00000	15.000000	416.00000
12	21420.000	107.00000	1418.0000	860.00000	16.000000	362.00000
13	17782.000	91.000000	1348.0000	779.00000	17.000000	242.00000
14	18983.000	99.000000	1283.0000	755.00000	18.000000	341.00000
15	20131.000	123.00000	1307.0000	858.00000	19.000000	383.00000
16	16962.000	86.000000	1288.0000	847.00000	20.000000	373.00000
17	21321.000	93.000000	1393.0000	850.00000	21.000000	467.00000
18	18991.000	76.000000	1291.0000	730.00000	22.000000	346.00000
19	19502.000	89.000000	1345.0000	866.00000	23.000000	345.00000
20	19962.000	73.000000	1318.0000	770.00000	24.000000	320.00000
21	16384.000	171.00000	1379.0000	742.00000	25.000000	263.00000
22	18109.000	191.00000	1321.0000	727.00000	26.000000	305.00000
23	18598.000	181.00000	1259.0000	836.00000	27.000000	327.00000
24	19192.000	159.00000	1244.0000	730.00000	28.000000	288.00000
25	17964.000	148.00000	1167.0000	728.00000	29.000000	270.00000
26	17343.000	175.00000	1179.0000	567.00000	30.000000	235.00000
27	18972.000	166.00000	1318.0000	793.00000	31.000000	348.00000
28	16920.000	180.00000	1351.0000	664.00000	32.000000	245.00000
29	19768.000	171.00000	1427.0000	769.00000	33.000000	345.00000
30	18474.000	171.00000	1435.0000	746.00000	34.000000	279.00000
31	20604.000	181.00000	1279.0000	756.00000	35.000000	352.00000
32	19881.000	[illegible]	1274.0000	880.00000	36.000000	359.00000
33	20530.000	183.00000	1285.0000	714.00000	37.000000	237.00000
34	19133.000	186.00000	1214.0000	852.00000	38.000000	328.00000
35	18545.000	168.00000	1101.0000	676.00000	39.000000	336.00000

INDEX OF VARIABLE = 7, VARIABLE TITLE: TOTAL SALARY EXPENSE

VARIABLE INDEX NUMBER:

OBS NO.	7
1	648445.00
2	667246.00
3	739912.00
4	682094.00
5	710957.00
6	715920.00
7	734719.00
8	718724.00
9	790215.00
10	768063.00
11	773970.00
12	808234.00
13	825066.00
14	763106.00
15	846636.00
16	843551.00
17	895567.00
18	865020.00
19	876054.00
20	897392.00
21	867782.00
22	905299.00
23	875966.00
24	866645.00
25	858674.00
26	883745.00
27	882696.00
28	843444.00
29	947861.00
30	909352.00
31	927531.00
32	915395.00
33	963011.00
34	973911.00
35	925649.00

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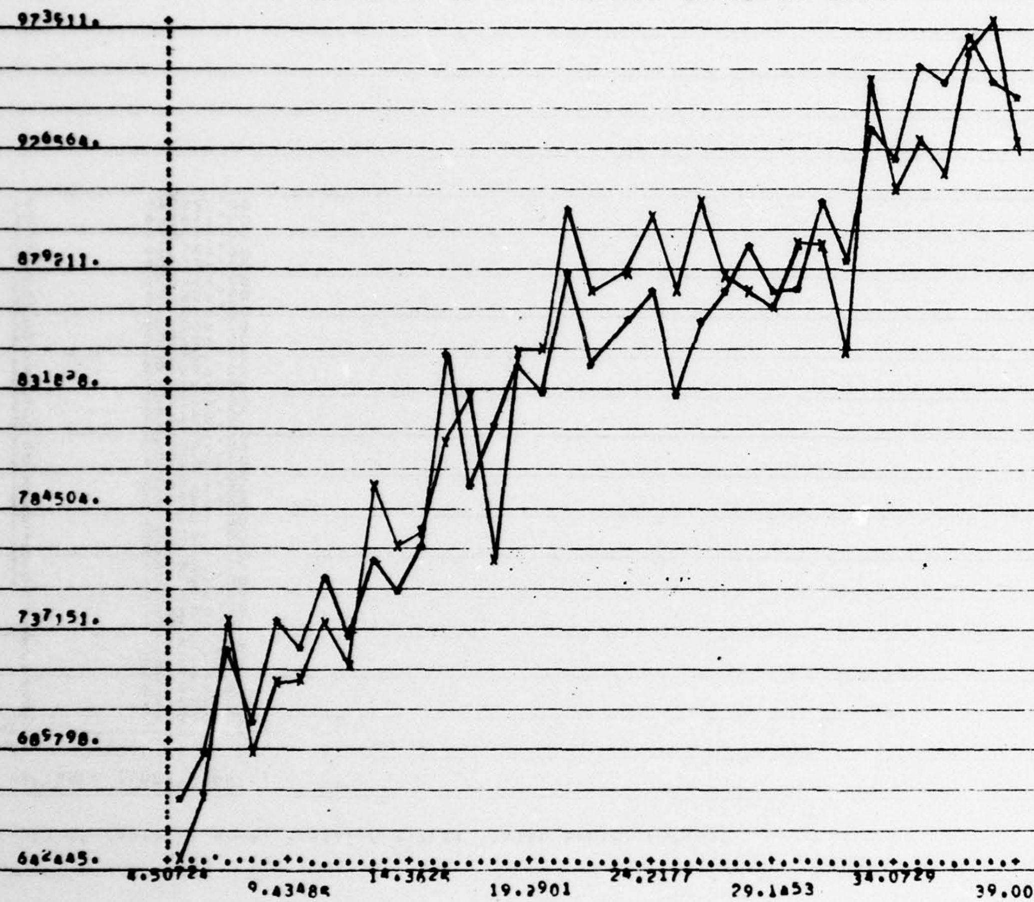
+++ DETRUTH REGRESSION X-Y PLOT ++

REGRESSION SERIES TITLE: HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY..OB..TOTAL SALARY..

REGRESSION EQUATION TITLE:

Y VARIABLE # 7 TITLE: TOTAL SALARY EXPENSE

(Y'S PLOTTED WITH AN X; Y ESTIMATES PLOTTED WITH AN *)



X VARIABLE # 5 TITLE: TIME FACTOR BETA.01

IMAGES OF DATA CARDS SUBMITTED FOR DETRUTH REGRESSION ANALYSIS

NOTE: THE NEXT 35 DATA-SET OBSERVATIONS BELOW WILL BE INTERPRETED BY THE FOLLOWING CONTROL CARD:
RAWDATA CC PRINT 07 VAR 035 OBS DATAFMT(I7,I4,I5,I4,I3,I4,I7)
(-- INDICATE PROPER COLUMNS FOR ENTERING PARAMETERS)

18427	139	1474	451	5	439	642445	1
15875	136	1319	453	6	426	667246	2
17447	138	1507	496	7	467	739912	3
[illegible]	109	1377	403	8	375	662094	4
17221	143	1549	477	9	439	710957	5
16308	138	1447	462	10	420	715920	6
17492	131	1539	415	11	391	734719	7
13481	115	1509	425	12	385	718724	8
[illegible]	110	1486	410	13	384	790215	9
15866	119	1481	414	14	376	768063	10
16988	122	1331	437	15	416	773970	11
21420	107	1415	660	16	385	808234	12
17782	091	1346	779	17	292	825066	13
16983	090	1283	755	18	321	763102	14
20131	123	1307	858	19	363	846636	15
18982	086	1268	847	20	373	843551	16
21301	093	1393	850	21	407	895567	17
18991	076	1291	730	22	344	865020	18
19502	089	1345	866	23	349	876054	19
19502	073	1316	770	24	320	897392	20
16384	171	1379	742	25	289	867782	21
18109	191	1321	727	26	305	905296	22
16598	181	1259	636	27	327	875966	23
19192	159	1244	730	28	286	866645	24
17064	198	1167	728	29	270	858674	25
17343	175	1179	567	30	235	883745	26
16872	166	1318	793	31	348	862696	27
16920	180	1351	864	32	245	843444	28
19768	171	1422	769	33	309	947861	29
18474	171	1435	746	34	279	909352	30
20604	181	1279	756	35	352	927531	31
19861	188	1274	880	36	359	918395	32
20530	183	1205	714	37	237	963011	33
19133	186	1214	852	38	328	973911	34
18545	168	1101	876	39	336	925649	35

TOTAL NUMBER OF DATA CARDS FOR REGRESSION INPUT: 35

7 VAR IN DATA-SET NO. 1 ABOVE ENTERED INTO COMPUTER UNDER FORMAT (I7,I4,I5,I4,I3,I4,I7)

CONTROL CARD BEING PROCESSED: PROTITL HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY--C--TOTAL SALARY--

CONTROL CARD BEING PROCESSED: VARNAME 01OB NURSE SALARY EXPENSE

CONTROL CARD BEING PROCESSED: VARNAME 02OB DISCHARGES

CONTROL CARD BEING PROCESSED: VARNAME 03TOTAL DISCHARGES

CONTROL CARD BEING PROCESSED: VARNAME 04OB PATIENT DAYS

CONTROL CARD BEING PROCESSED: VARNAME 05TIME FACTOR BETA+01

CONTROL CARD BEING PROCESSED: VARNAME 06NEWBORN DAYS OF CARE

CONTROL CARD BEING PROCESSED: VARNAME 07TOTAL SALARY EXPENSE

CONTROL CARD BEING PROCESSED: PRINTIT 07 VARS INDEXED 01 02 03 04 05 06 07

```
                    DETRUTH ECONOMETRIC PACKAGE    VERSION  06/20/77  13:27

DETRUTH REGRESSION ANALYSIS PARAMETER LIMITS FOR THIS RUN ARE:
 250 = MAXIMUM LIMIT FOR OBSERVATIONS,
  51 = MAXIMUM LIMIT FOR SUM OF RAW AND CALCULATED VARIABLES,
  50 = MAXIMUM LIMIT FOR NUMBER OF INDEPENDENT VARIABLES USED IN A REGRESSION ANALYSIS.

------------------------------ IMAGES OF CONTROL CARDS SUBMITTED FOR DETRUTH REGRESSION ANALYSIS ------------------------------
        10        20        30        40        50        60        70        80          (CARD NUMBER)

PROTITL HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY**C6**TOTAL SALARY**          1
VARNAME C1OB NURSE SALARY EXPENSE                                                2
VARNAME C2OB DISCHARGES                                                          3
VARNAME C3TOTAL DISCHARGES                                                       4
VARNAME C4OB PATIENT DAYS                                                        5
VARNAME C5TIME FACTOR BETA*01                                                    6
VARNAME C6NEWBORN DAYS OF CARE                                                   7
VARNAME C7TOTAL SALARY EXPENSE                                                   8
PRINTIT C7 VARS INDEXED C1 02 03 04 05 05 07                                     9
XYPLOT WITH X = C2                                                               10
REGRESS DEP C1, IND 02 04 06 05                                                  11
XYPLOT WITH X = C2                                                               12
REGRESS DEP C7, IND 03 01 05                                                     13
RAWDATA CU PRINT 07 VAR 034 OBS DATAFMT(I7,I4,I5,I4,I3,I4,I7)                    14
END                                                                              15
.................................................... TOTAL NUMBER OF DETRUTH CONTROL CARDS SUBMITTED:   15
```

```
100   PROTITL HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY**OB**TOTAL SALARY**
200   VARNAME 01OB NURSE SALARY EXPENSE
300   VARNAME 02OB DISCHARGES
400   VARNAME 03TOTAL DISCHARGES
500   VARNAME 04OB PATIENT DAYS
600   VARNAME 05TIME FACTOR BETA*01
700   VARNAME 06NEWBORN DAYS OF CARE
800   VARNAME 07TOTAL SALARY EXPENSE
900   PRINTIT 07 VARS INDEXED 01 02 03 04 05 06 07
1000  XYPLOT WITH X = 05
1100  REGRESS DEP 01, IND 02 04 06 05
1200  XYPLOT WITH X = 05
1300  REGRESS DEP 07, IND 03 01 05
1400  RANDATA DO PRINT 07 VAR 035 OBS DATAFMT(I7,I4,I5,I4,I3,I4,I7)
1500    14627 133 1474 451  5 435 642445
1600    15875 136 1319 453  6 426 667246
1700    17447 138 1587 496  7 467 739912
1800    15400 103 1377 403  8 375 682094
1900    17221 143 1549 477  9 439 710957
2000    15308 138 1447 462 10 429 715920
2100    17492 131 1539 415 11 391 734719
2200    15481 115 1509 425 12 385 718724
2300    17065 110 1486 410 13 385 790215
2400    15806 119 1481 414 14 376 768065
2500    15958 122 1331 437 15 416 773970
2600    21920 107 1419 960 16 382 808234
2700    17782 091 1348 779 17 292 825066
2800    16963 099 1283 755 18 321 763102
2900    20131 123 1307 558 19 363 846636
3000    15962 086 1268 547 20 373 843551
3100    21321 093 1393 550 21 407 895567
3200    16991 076 1291 730 22 346 865020
3300    19502 089 1305 566 23 345 876058
3400    19962 073 1318 770 24 320 897592
3500    16394 171 1379 742 25 293 867782
3600    15109 191 1321 727 26 305 905296
3700    18598 181 1257 536 27 327 875966
3800    19192 159 1244 730 28 286 866645
3900    17964 148 1167 728 29 270 858574
4000    17343 175 1179 567 30 235 883745
4100    19972 166 1318 793 31 349 882696
```

```
4300    19768 171 1427 769 33 305 947561
4400    19474 171 1435 746 34 279 909552
4500    20604 161 1279 756 35 352 927531
4600    19861 188 1274 680 36 359 915595
4700    20530 163 1285 714 37 237 955011
4800    19153 186 1214 552 38 329 973911
4900    18545 168 1101 576 39 335 925649
5000  END
```

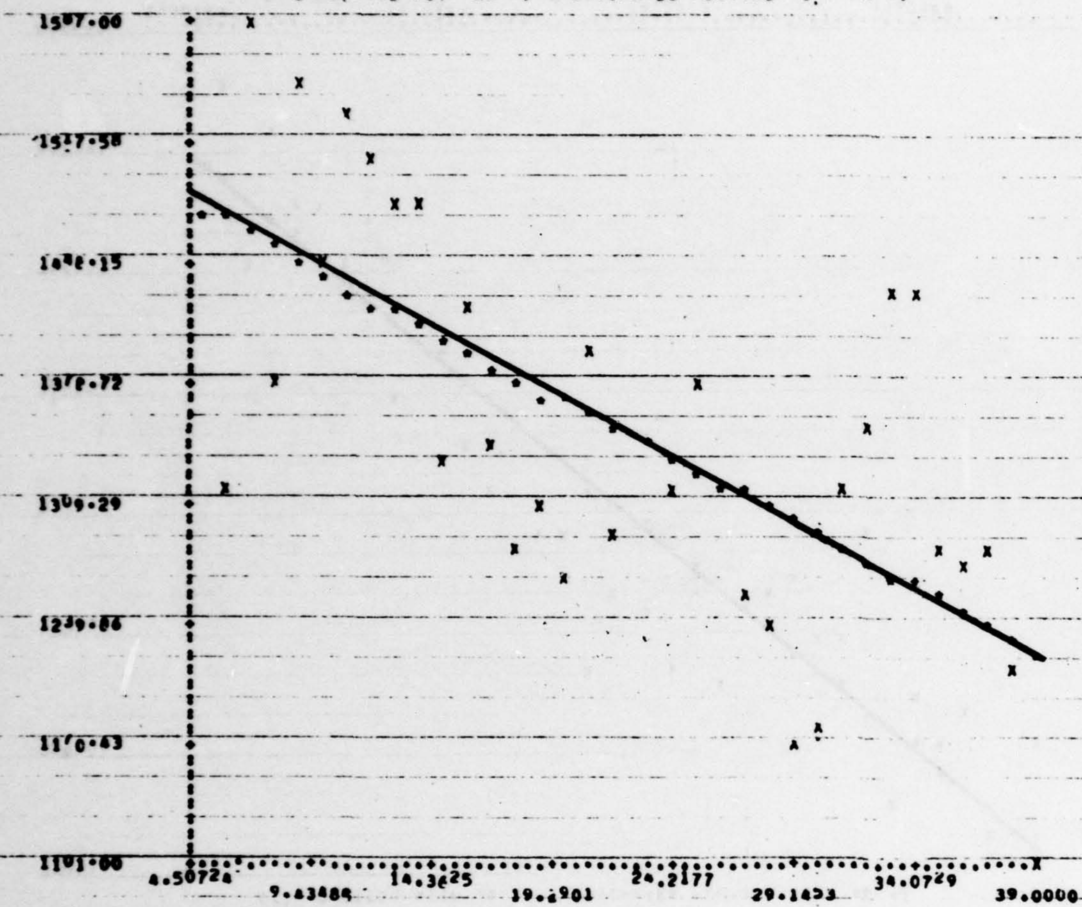
++ DEIRUTH REGRESSION X-Y PLOT ++

REGRESSION SERIES TITLE: HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY..........ALPHA #1..UB..

REGRESSION EQUATION TITLE:

Y VARIABLE # 7 TITLE: TOTAL DISCHARGES

(Y'S PLOTTED WITH AN X, Y ESTIMATES PLOTTED WITH AN .)



X VARIABLE # 10 TITLE: TIME FACTOR BETA=01

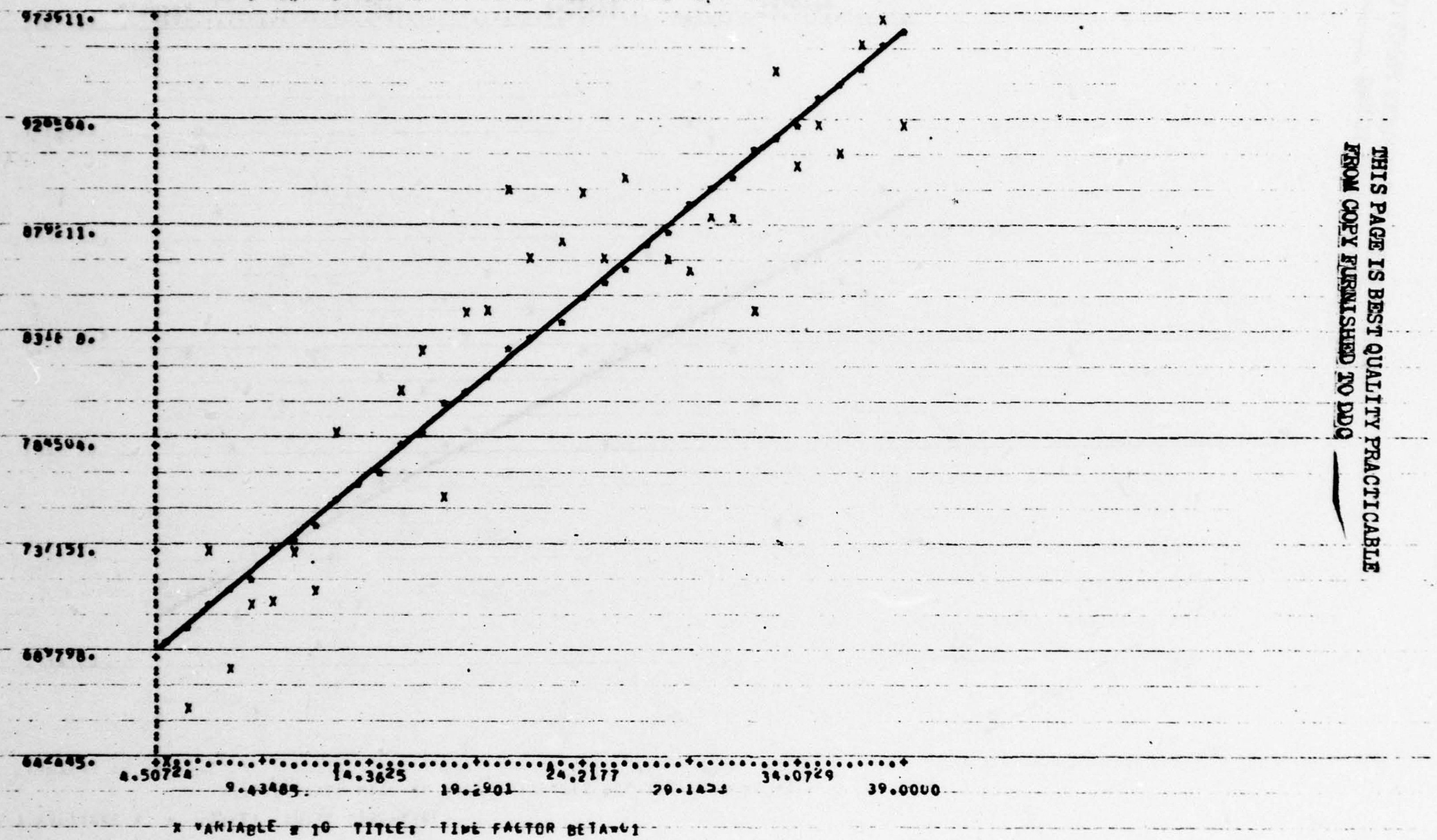
** DEIRUTH REGRESSION X-Y PLOT **

REGRESSION SERIES TITLE: HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY***********ALPHA P1**U6**

REGRESSION EQUATION TITLE:

Y VARIABLE # 14 TITLE: TOTAL SALARY-PENROSE

(Y'S PLOTTED WITH AN X; Y ESTIMATES PLOTTED WITH AN *)



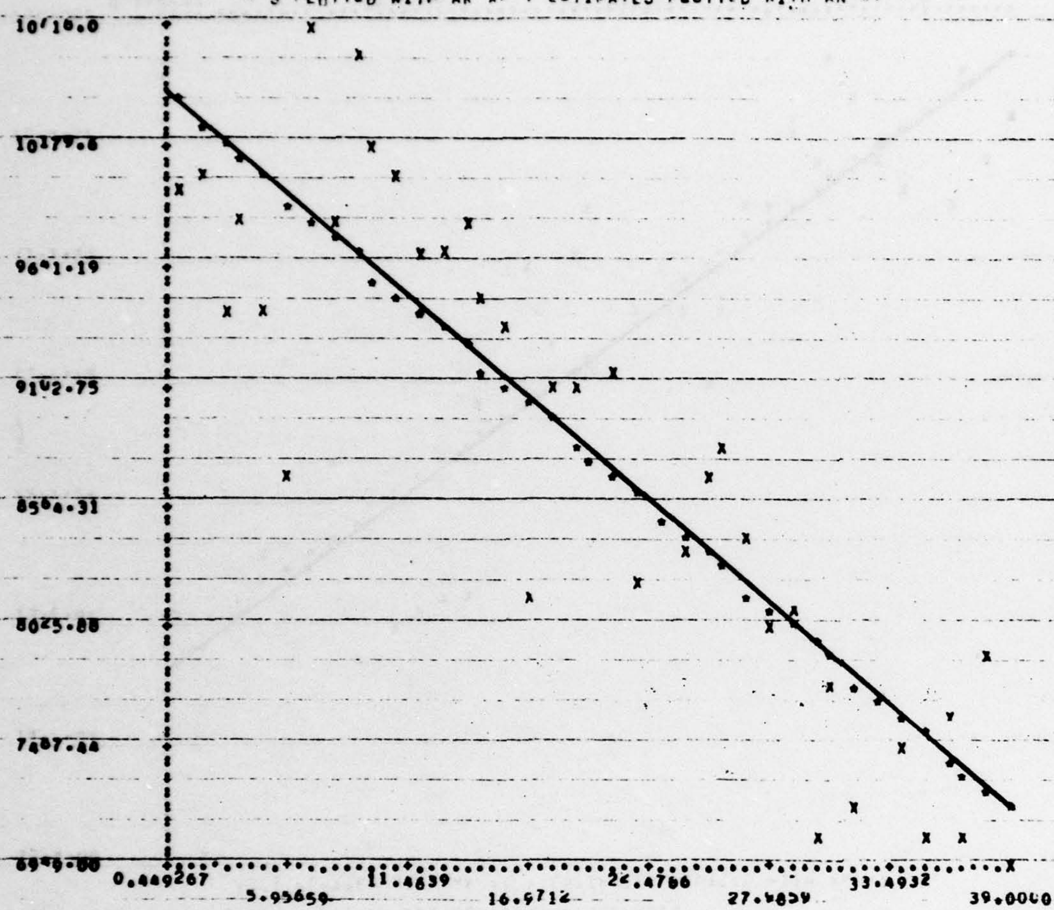
+++ DETRUTH REGRESSION X-Y PLOT ++

REGRESSION SERIES TITLE: HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY*********ALPHA #2*MS**

REGRESSION EQUATION TITLE:

Y VARIABLE # 7 TITLE: MEDICAL AND SURGICAL PATIENT DAYS OF CARE

(Y'S PLOTTED WITH AN X; Y ESTIMATES PLOTTED WITH AN *)



X VARIABLE # 3 TITLE: TIME FACTOR BETA #1

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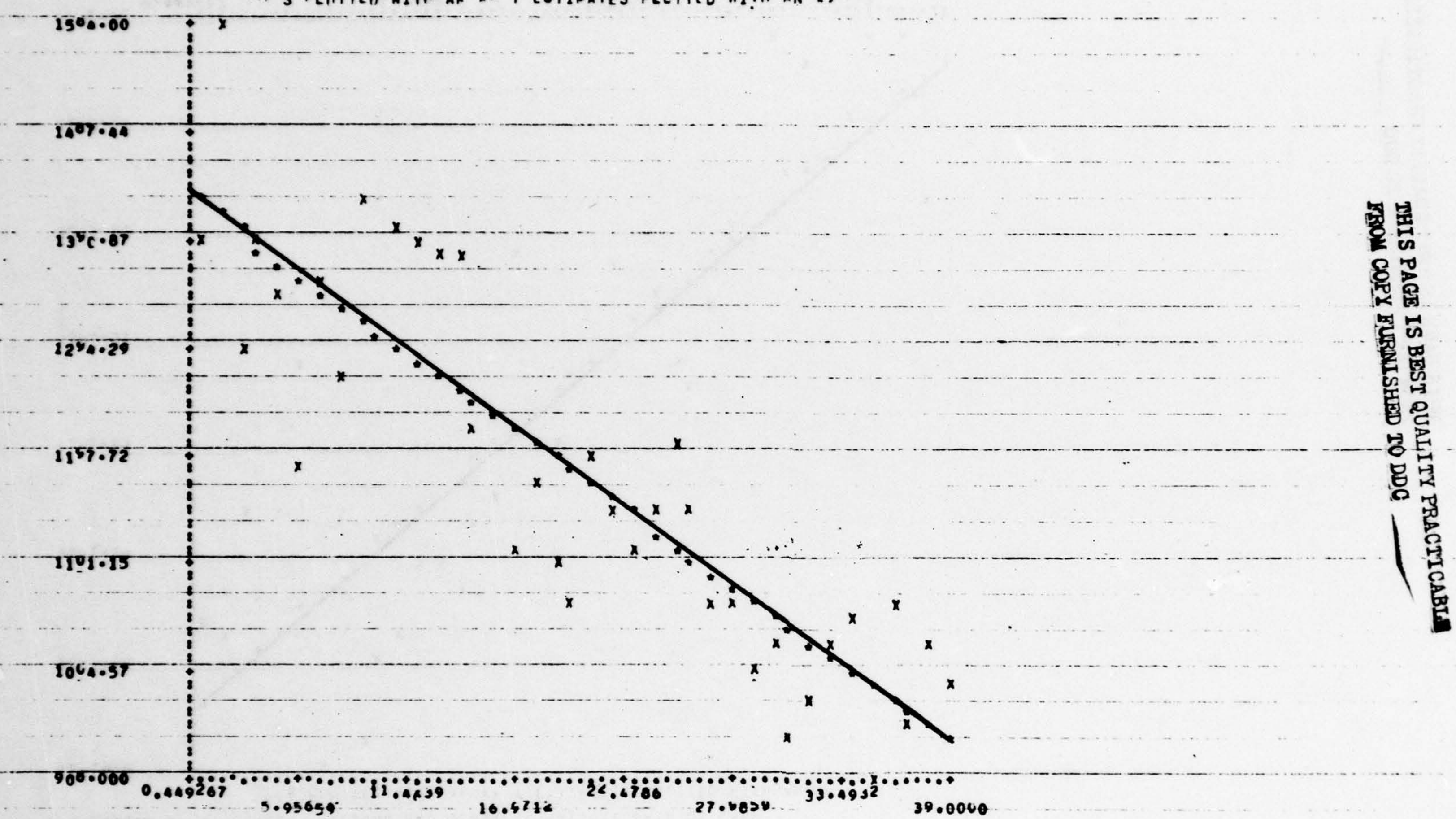
++ DEIRUTH REGRESSION X-Y PLOT ++

REGRESSION SERIES TITLE: HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY+++++++++ALPHA #2++RS++

REGRESSION EQUATION TITLE:

Y VARIABLE # 6 TITLE: MEDICAL AND SURGICAL DISCHARGES

(Y'S PLOTTED WITH AN X; Y ESTIMATES PLOTTED WITH AN *)



X VARIABLE # 3 TITLE: TIME FACTOR BETA #1

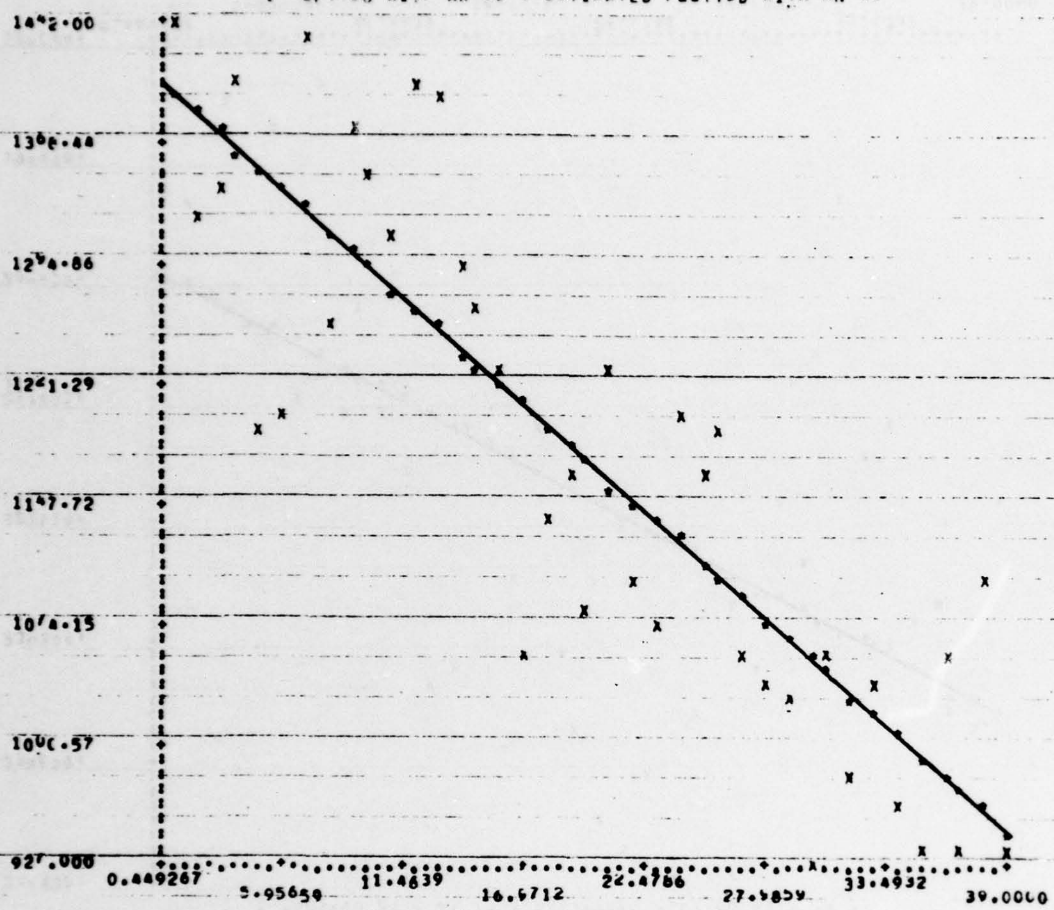
++ DEIRUTH REGRESSION X-Y PLOT ++

REGRESSION SERIES TITLE: HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY**********ALPHA #2**HS**

REGRESSION EQUATION TITLE:

Y VARIABLE # 5 TITLE: MEDICAL AND SURGICAL ADMISSIONS

(Y'S PLOTTED WITH AN X; Y ESTIMATES PLOTTED WITH AN *)



X VARIABLE # 3 TITLE: TIME FACTOR BETA #1

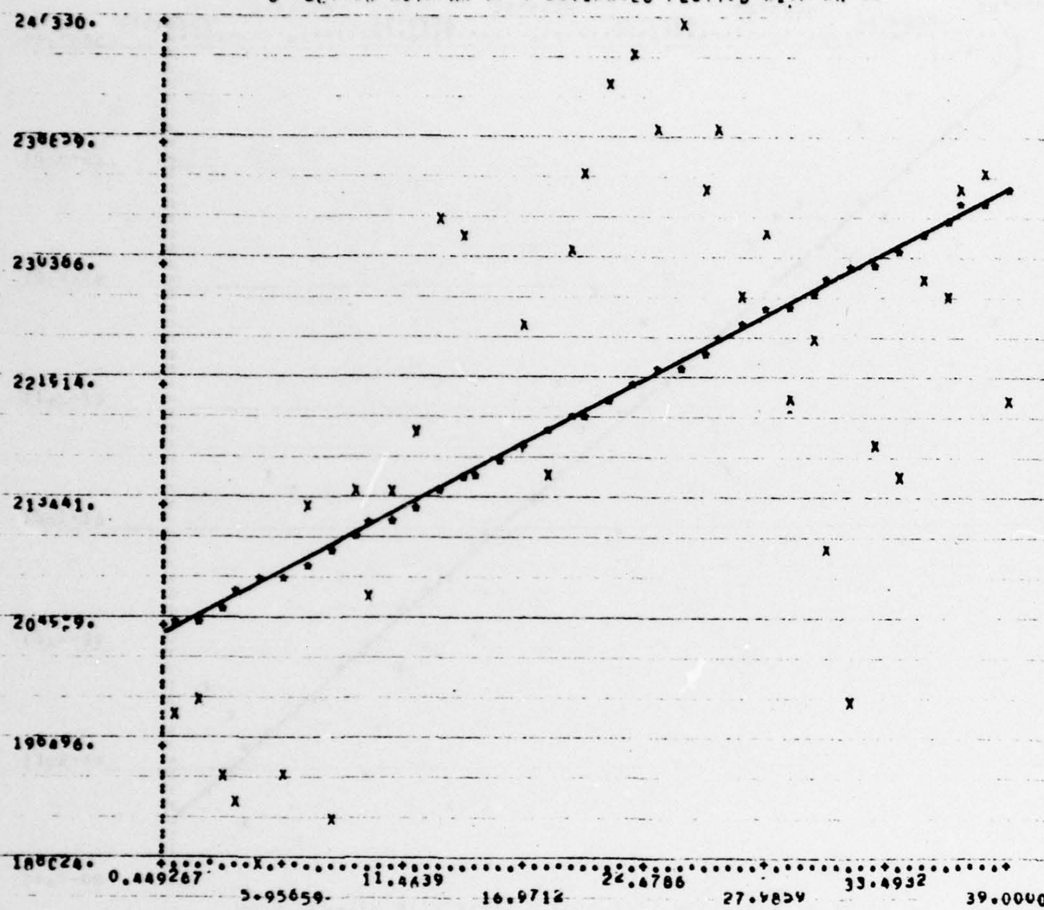
+++ DETROIT REGRESSION X-Y PLOT +++

REGRESSION SERIES TITLE: HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY*********ALPHA *2**PS**

REGRESSION EQUATION TITLE:

Y VARIABLE # 4 TITLE: NURSE SALARY****MEDICAL/SURGICAL****

(Y'S PLOTTED WITH AN X; Y ESTIMATES PLOTTED WITH AN *)



X VARIABLE # 3 TITLE: TIME FACTOR BETA #1

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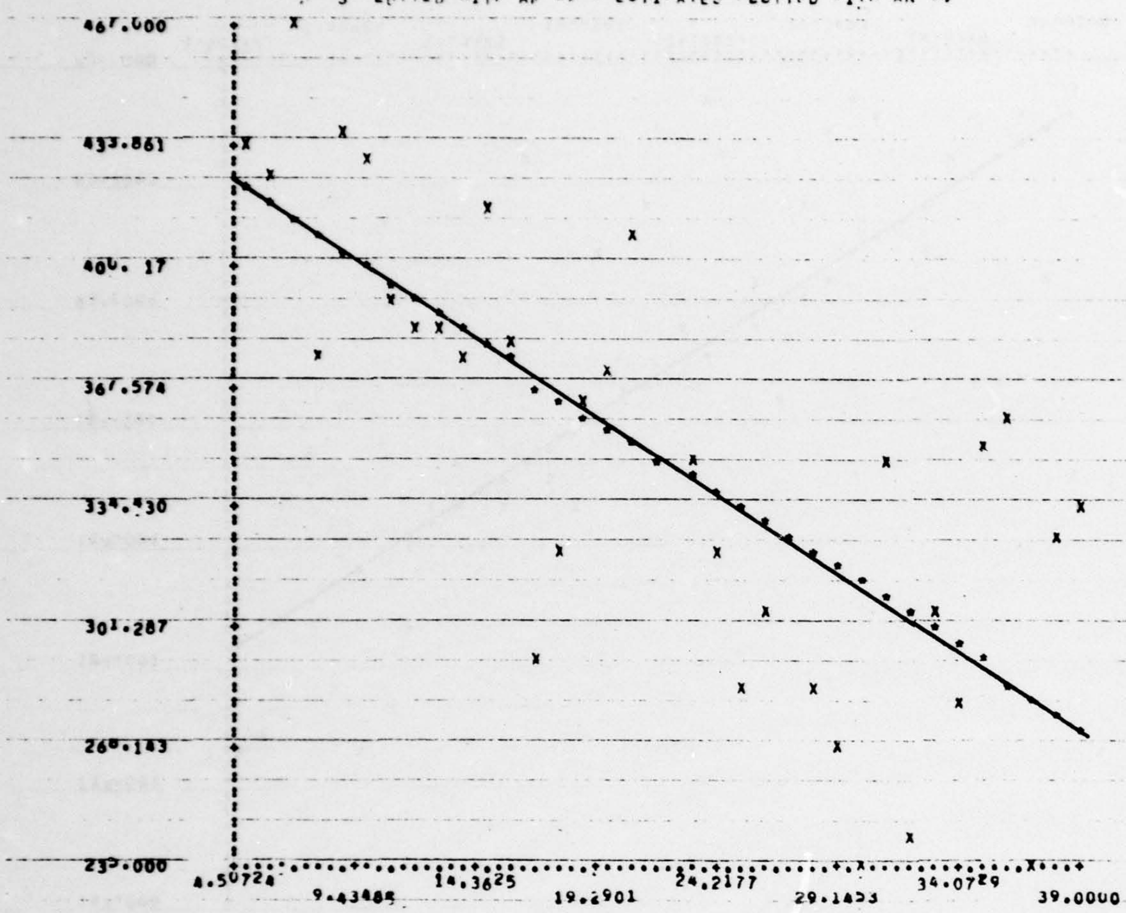
++ DEIRUTH REGRESSION X-Y PLOT ++

REGRESSION SERIES TITLE: HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY**********ALPHA =1..08..

REGRESSION EQUATION TITLE:

Y VARIABLE # 11 TITLE: NEWBORN DAYS OF CARE

(Y'S PLOTTED WITH AN X; Y ESTIMATES PLOTTED WITH AN *)



X VARIABLE # 10 TITLE: TIME FACTOR BETA=01

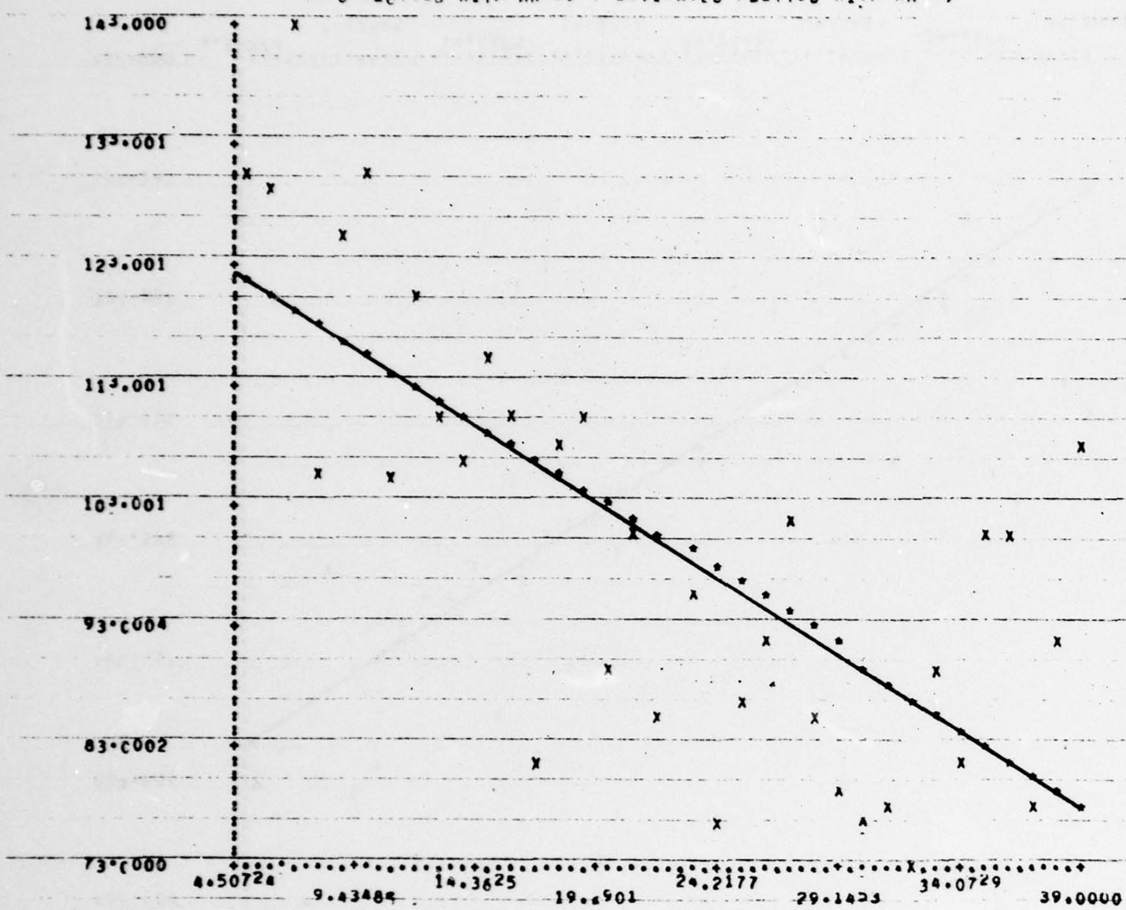
++ DETRUTH REGRESSION X-Y PLOT ++

REGRESSION SERIES TITLE: HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY**********ALPHA #1**L8**

REGRESSION EQUATION TITLE:

Y VARIABLE # 12 TITLE: DELIVERIES

(Y'S PLOTTED WITH AN X; Y ESTIMATES PLOTTED WITH AN *)



X VARIABLE # 10 TITLE: TIME FACTOR BETA*01

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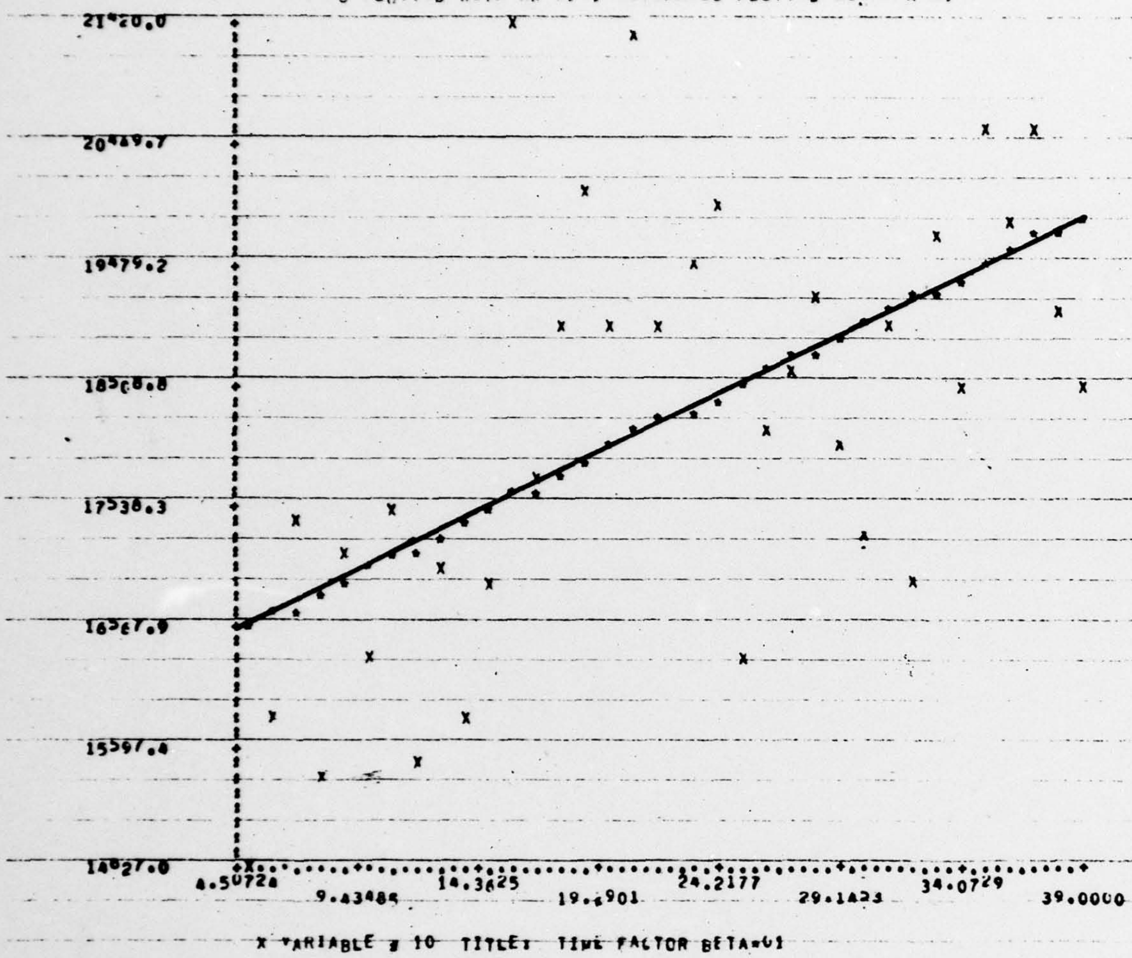
** DEIRUTH REGRESSION X-Y PLOT **

REGRESSION SERIES TITLE: HOSPITAL COST PREDICTIVE ECONOMETRIC SURVEY**********ALPHA #1**LB**

REGRESSION EQUATION TITLE:

Y VARIABLE # 1 TITLE: OR NURSE SALARY

(Y'S PLOTTED WITH AN X; Y ESTIMATES PLOTTED WITH AN *)



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